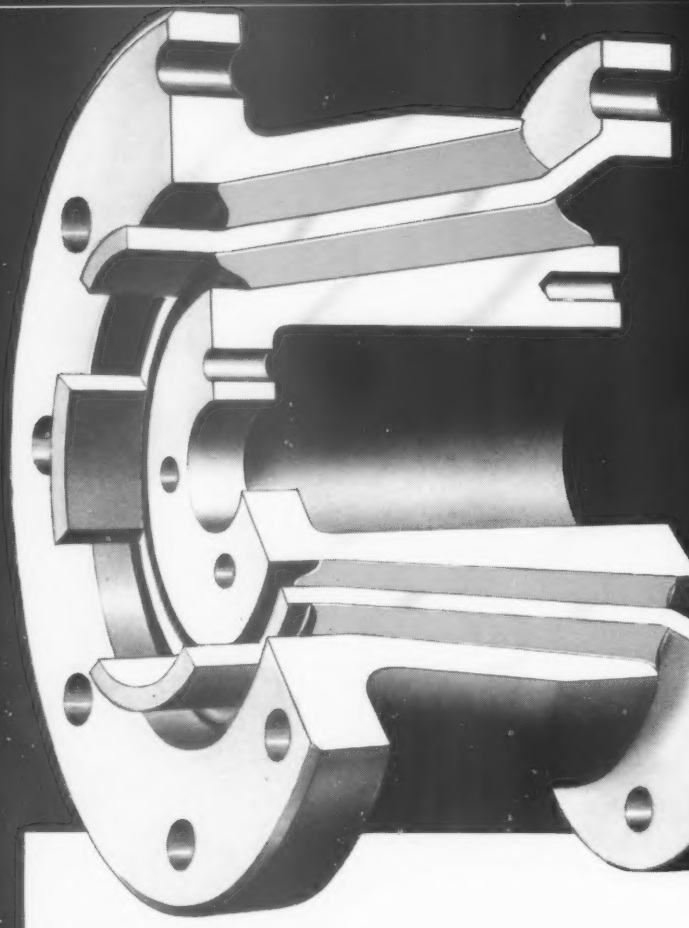
Mechanical World

AND ENGINEERING RECORD

Monthly: Two Shillings and Sixpence — Established 1876 — JUNE, 1960



Double-cone couplings

(PATENTED)

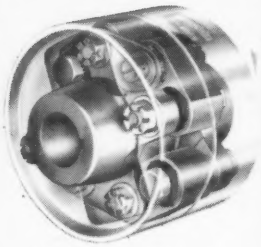
Damp Torsional Vibration, Resist Thrust, Absorb Shock Loads

A high degree of torsional flexibility combined with large torque capacity singles out the Double-Cone Coupling for drives in which torque fluctuations and torsional vibration must be controlled.

The design is suitable for torques up to 100,000 lb. ins. and torsional deflections from 5°-10°. It permits some angular misalignment and is designed to resist end thrust.

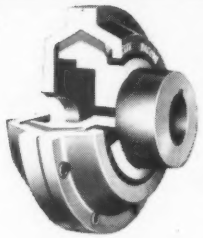
Available in a number of standard sizes, the Double-Cone Coupling is of robust construction and requires no maintenance.

SOME OTHER METALASTIK COUPLINGS



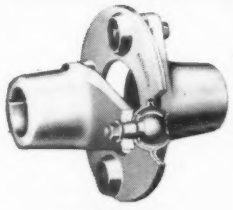
TRAILING LINK

Accommodates exceptional parallel misalignment. In range of sizes to transmit 1-20 h.p. per 100 r.p.m.



BICONE

For marine and other applications, transmits thrust, absorbs torsional vibration and accommodates misalignment. For drives of 5-10 h.p. per 100 r.p.m.



UNIVERSAL

Accommodates a large amount of angular misalignment with very low resistance. In sizes to transmit 0·3–3 h.p. per 100 r.p.m.

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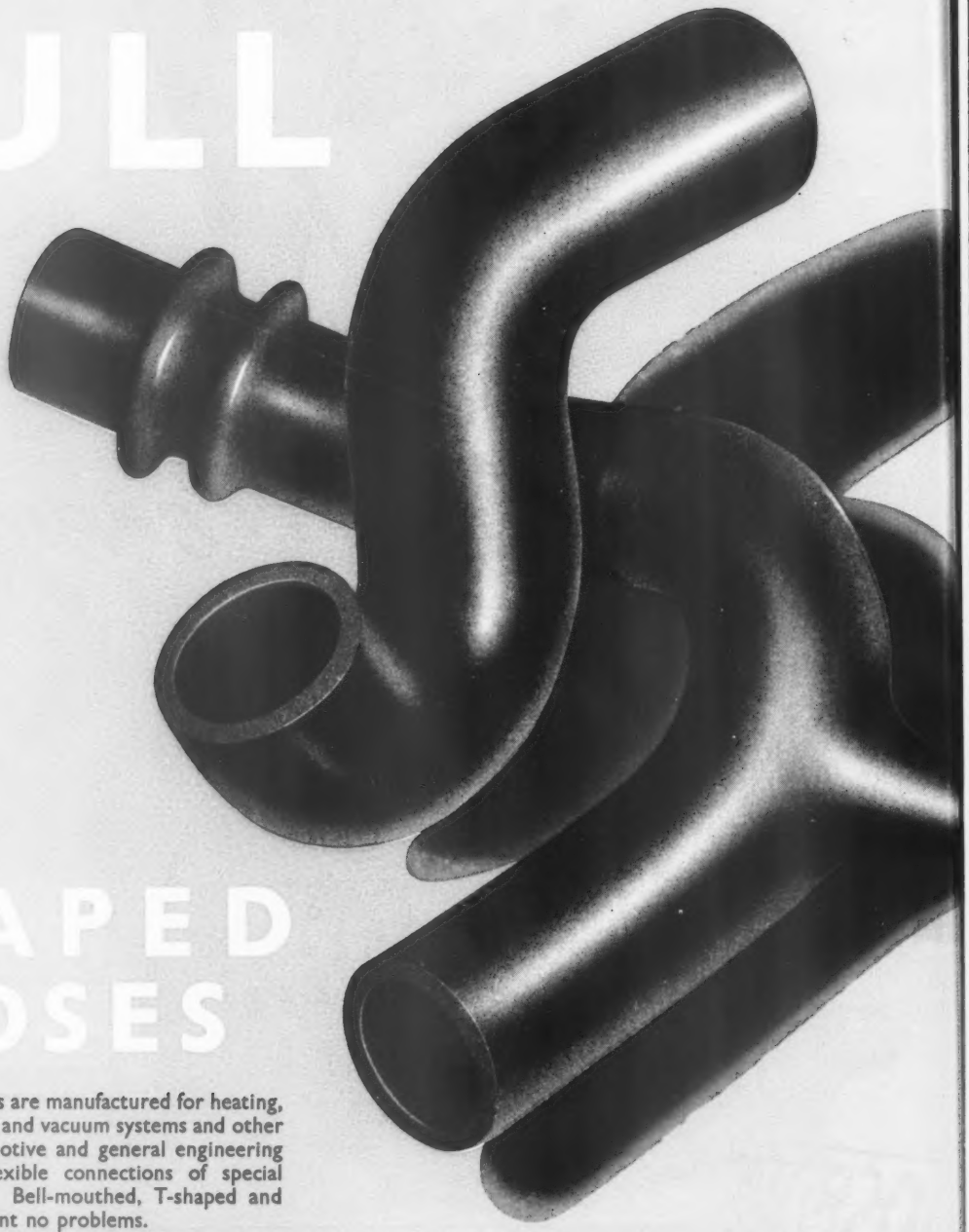

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John Bull shaped hoses are manufactured for heating, cooling, air-induction and vacuum systems and other applications in automotive and general engineering where high-duty, flexible connections of special shape are required. Bell-mouthed, T-shaped and branched hoses present no problems.

Moulded or mandrel-formed according to construction and manufactured in high-grade natural or synthetic rubber with fabric reinforcement where required, John Bull hoses provide maximum life under the most severe conditions.

In addition to Shaped Hoses, John Bull products include Boots and Gaiters, Convoluted Hose and Rubber Mouldings.

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FSC Coupling

FSP Drive

CONTROLLED ACCELERATION TO FULL POWER

and every drive guaranteed!

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- Smooth controlled acceleration as well as protection of both motors and machines from damage due to stalling and overload.
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- Reduced initial cost of motors and starting gear.
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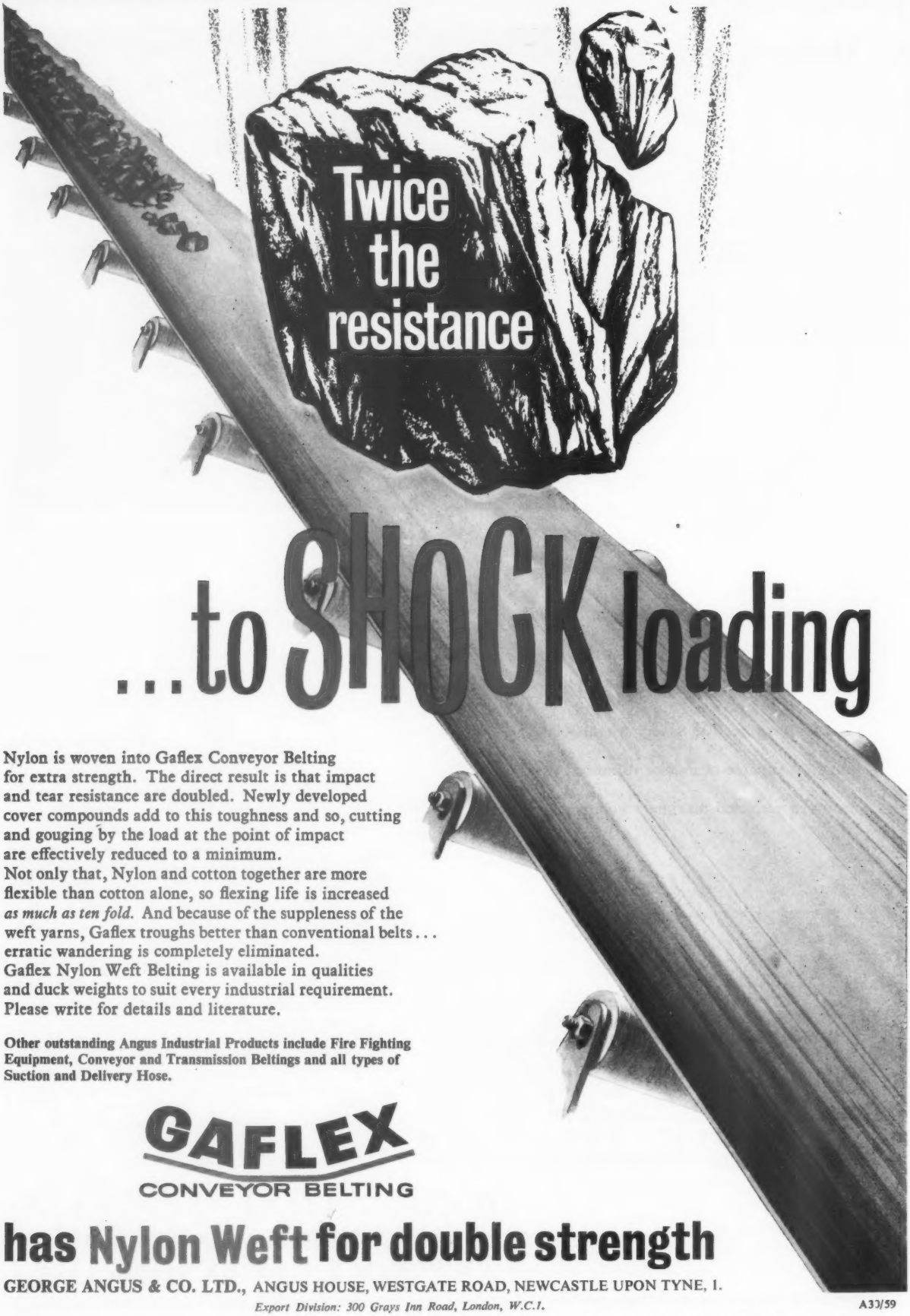

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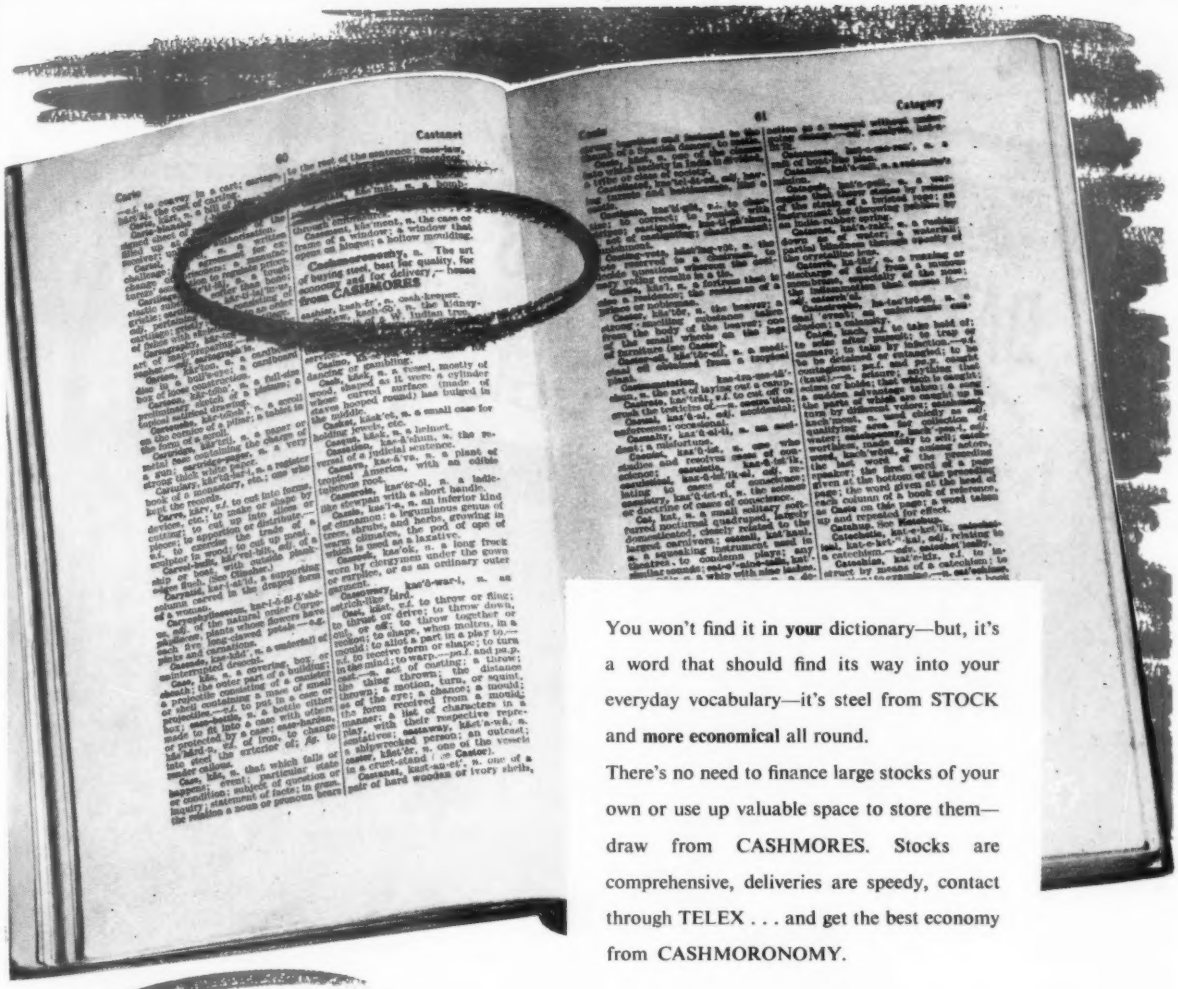

You won't find it in **your** dictionary—but, it's a word that should find its way into your everyday vocabulary—it's steel from STOCK and **more economical** all round.

There's no need to finance large stocks of your own or use up valuable space to store them—draw from CASHMORES. Stocks are comprehensive, deliveries are speedy, contact through TELEX . . . and get the best economy from CASHMORONOMY.

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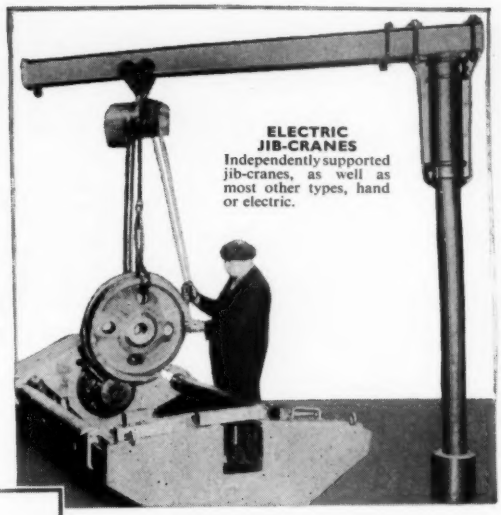

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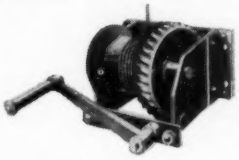
Independently supported jib-cranes, as well as most other types, hand or electric.

LIGHTWEIGHT PULLEY-BLOCKS
Extra light in weight. Ideal for maintenance work. Sizes ½ to 5-tons.

TRIPLE-GEAR PULLEY-BLOCKS
Highly efficient ball bearing pulley-blocks, with genuine triple-gear mechanism. Sizes up to 20-tons.

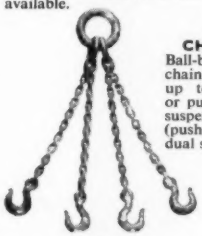
LEVER PULL-HOISTS
Powerful, patent lever pull-hoists with flexible chain for either pulling or lifting. Sizes ¾, 1½ and 3-tons.

STACKING MACHINES
Stackers for either hand or power operation in sizes ½, ½ and 1-ton and with various alternative platforms to suit the goods to be stacked.



WALL HOISTS
Self-sustaining, machine-cut worm-gear wire rope wall hoists in sizes from ½ to 2-tons.
Spur-gear wall hoists for use with chain in sizes ½ to 2-tons available.

ELECTRIC CHAIN HOISTS
Ball-bearing electric chain hoists for loads up to 1-ton. Pendant or push button control, suspension, travelling (push or geared) and dual speed types.



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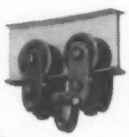
All types of steel chain slings, chains to B.S.1663, hooks to B.S.2903 also case and cask slings with adjustable clutches



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Travelling trolleys, geared or ungeared and adjustable for varying track widths, for either straight or curved tracks.

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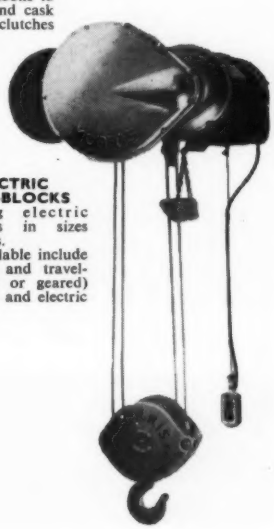
Easily steered and foot operated elevating trucks for loads up to 1-ton.

PORTABLE JIB-CRANES
Handy tubular jib-cranes in sizes ½, 1 and 2-tons. Machine-cut hoisting gears, self-sustaining brake, roller bearing floor wheels.



ELECTRIC HOIST-BLOCKS
Ball-bearing electric hoist-blocks in sizes ½ to 10-tons.
Types available include suspension and travelling (push or geared) dual speed and electric travelling.

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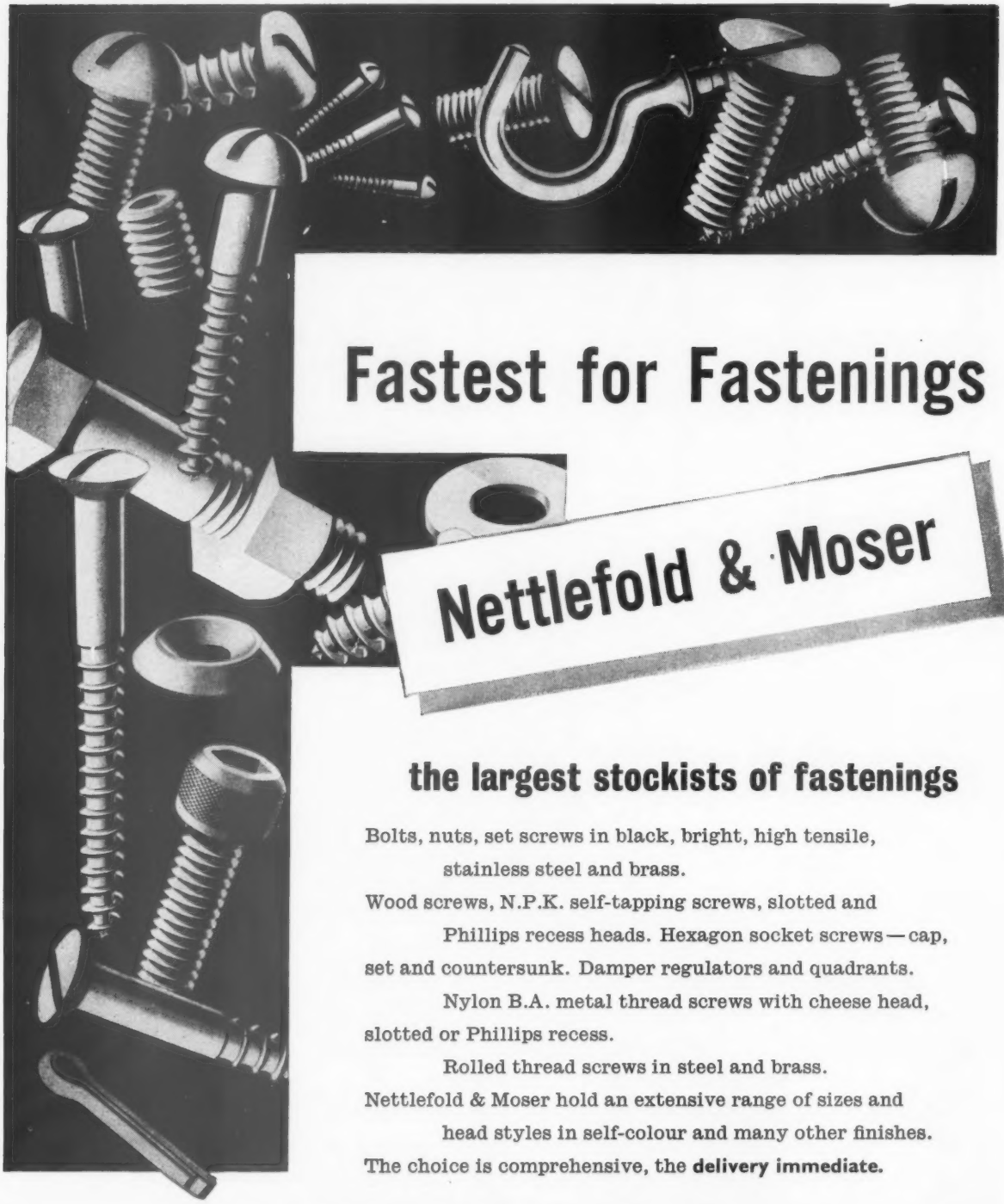

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USE IT WHERE MORE POWER IS REQUIRED IN THE SAME DRIVING SPACE.
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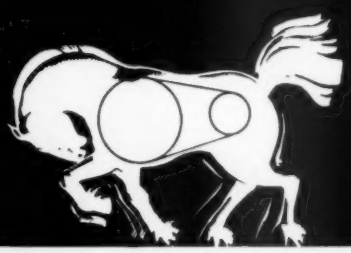

MORE POWER IN THE SAME SPACE

TURNERS

POLY-V (TRADE MARK) DRIVE

YOU can improve your power transmission applications
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Advantages of THE "POLY-V" DRIVE

- **"POLY-V" Belts transmit the same horse power as conventional V-belts on very much narrower pulleys.**
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- **Constant pitch diameters at all loads are maintained on "POLY-V" Drives.**
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- **"POLY-V" Drives provide greater interchangeability of belts and pulleys because there are only two belt cross sections instead of five for multiple V-belt drives.**
- **Longer lives of belts and pulleys are obtained on "POLY-V" Drives.**
- **"POLY-V" Belts are heat and oil resistant.**
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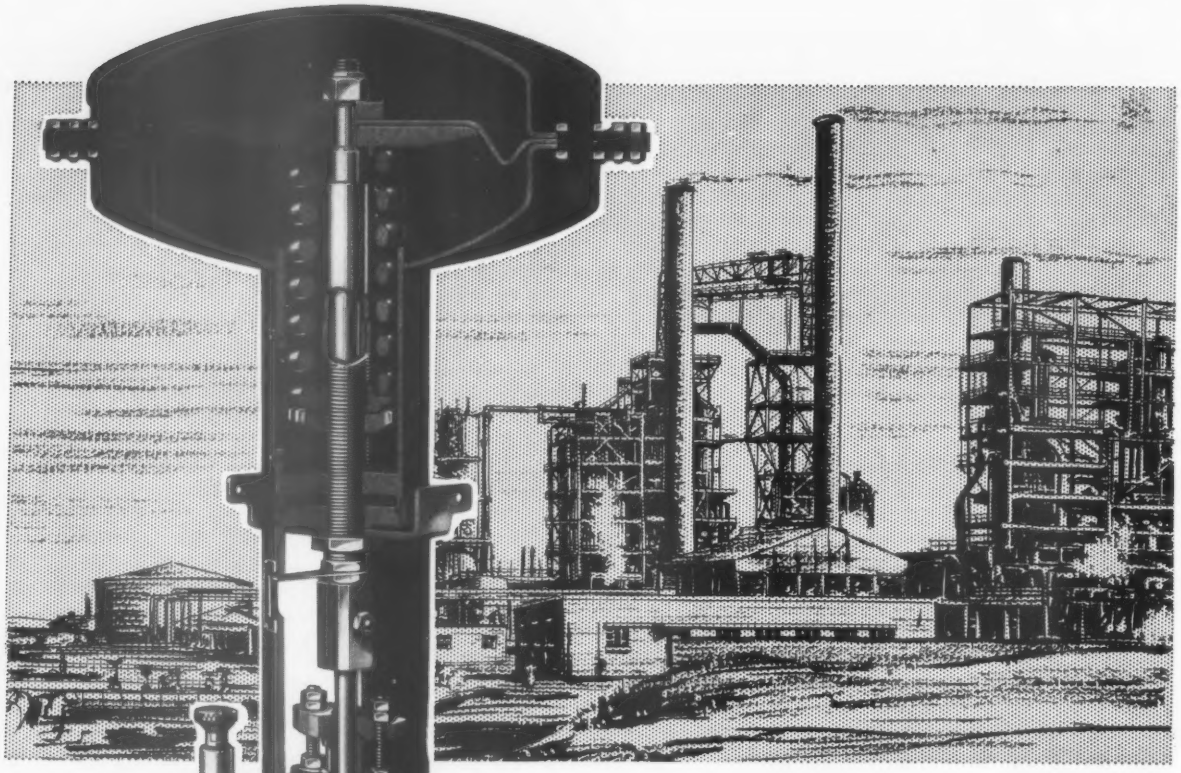

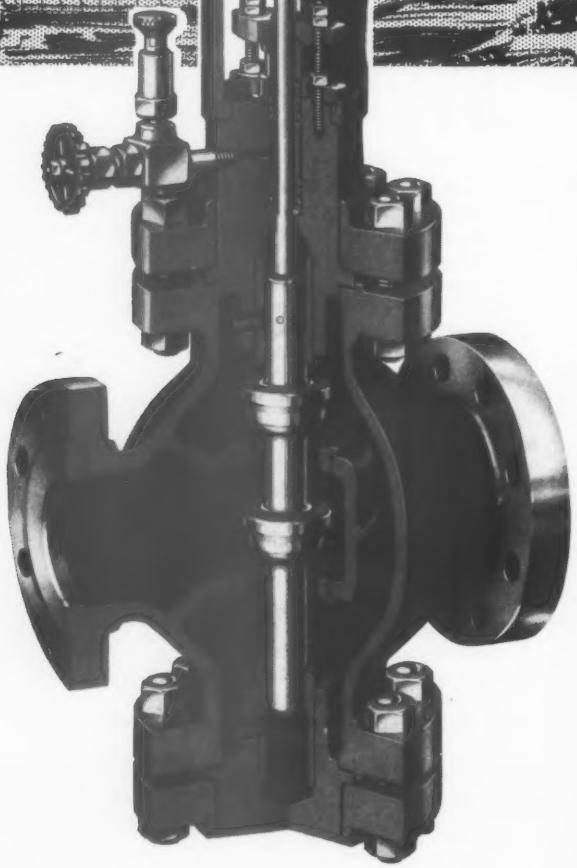

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Accurate, reliable, and economical, these Blakeborough types do full justice to the performance of the controlling instrument—hence their widespread use on modern automatic process control systems. An advanced and comprehensive range, well worth investigating.

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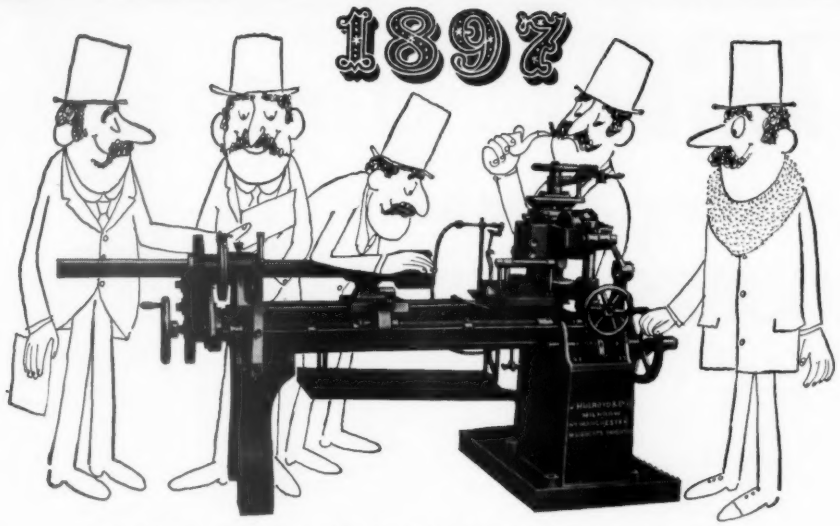

In 1897 we brought out the first Holroyd screw-thread milling machine. Three years later it won a Gold Medal at the Paris Exhibition. Today, it can be seen at the South Kensington Science Museum, London.

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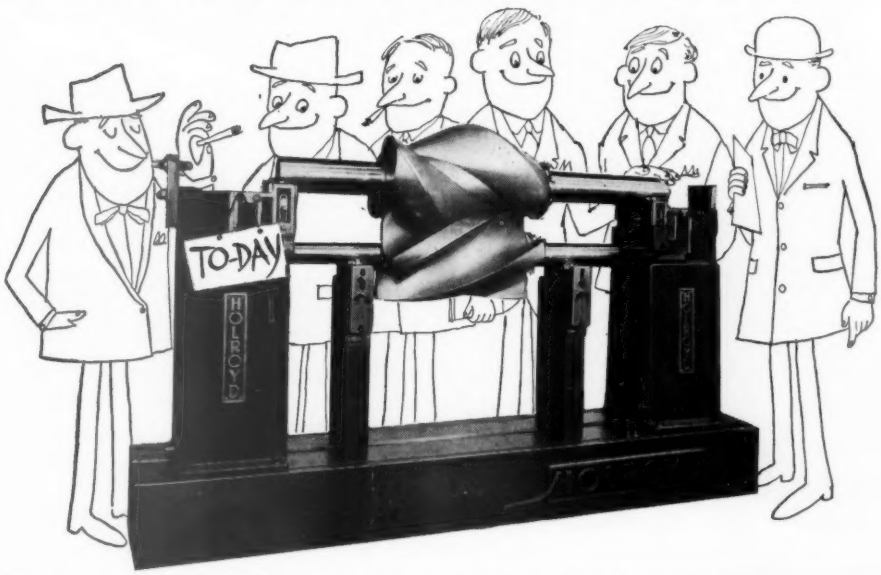

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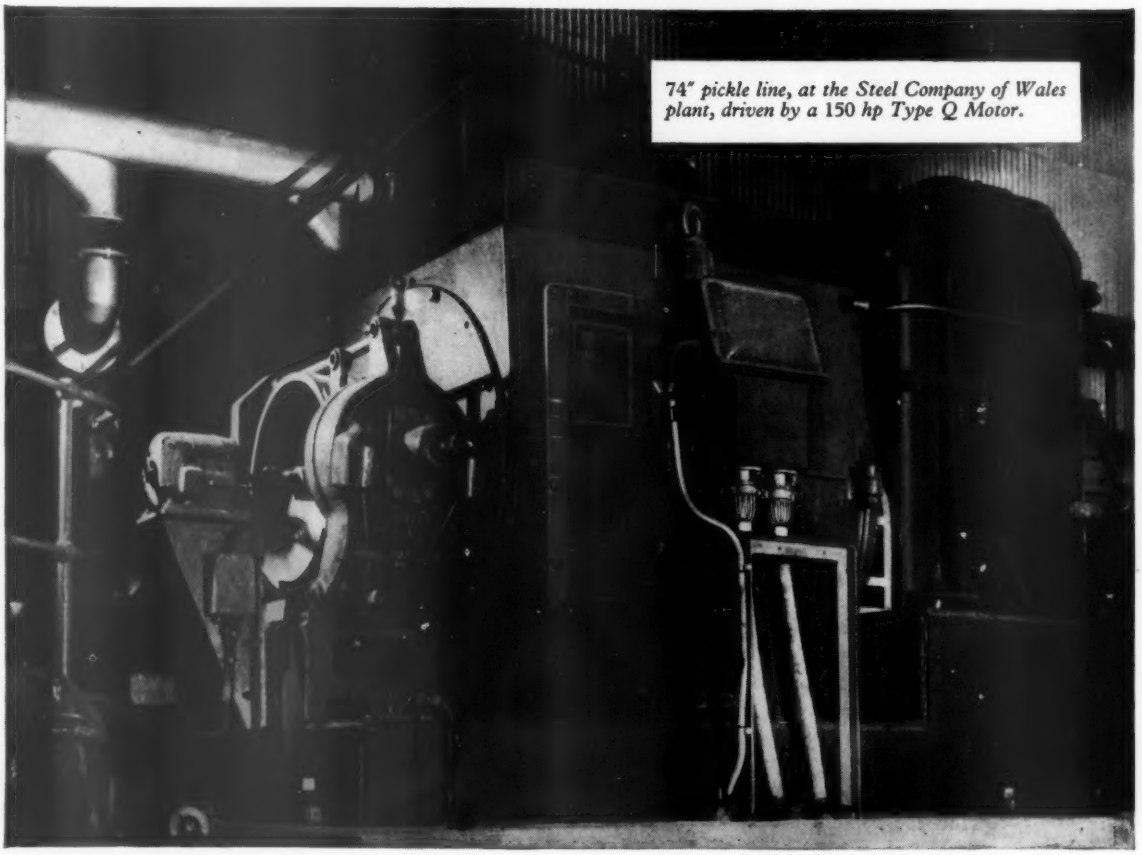
1078xa

Type Q Motors

FOR DUSTY ATMOSPHERES



74" pickle line, at the Steel Company of Wales plant, driven by a 150 hp Type Q Motor.

Specially designed for operation in dusty or corrosive conditions, the AEI Type Q totally-enclosed closed-air-circuit d.c. motor incorporates many improvements which help to simplify maintenance.

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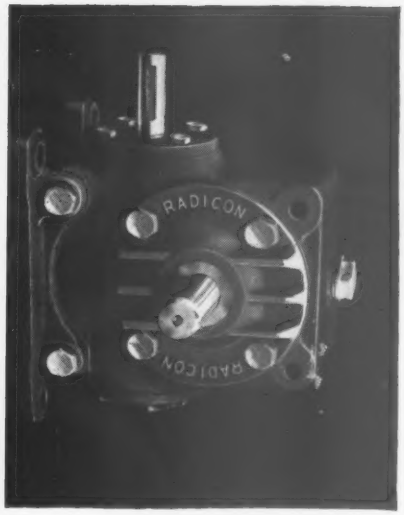

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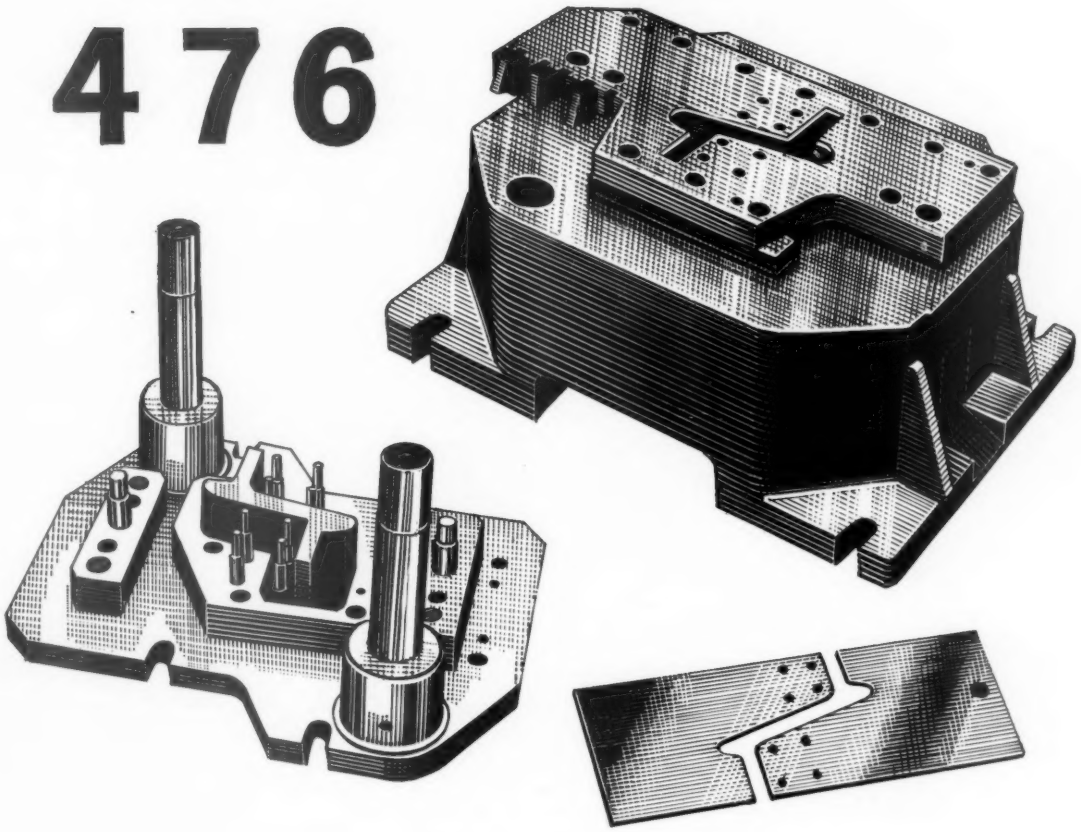
100 YEARS 1860-1960

SANDERSON tool steels

476



'476' Heavy duty die steel of the high carbon, high chromium type, has outstanding wear-resistance but is tough and machinable. It is particularly recommended for tools operating under conditions of severe wear and abrasion and where maximum runs are required.

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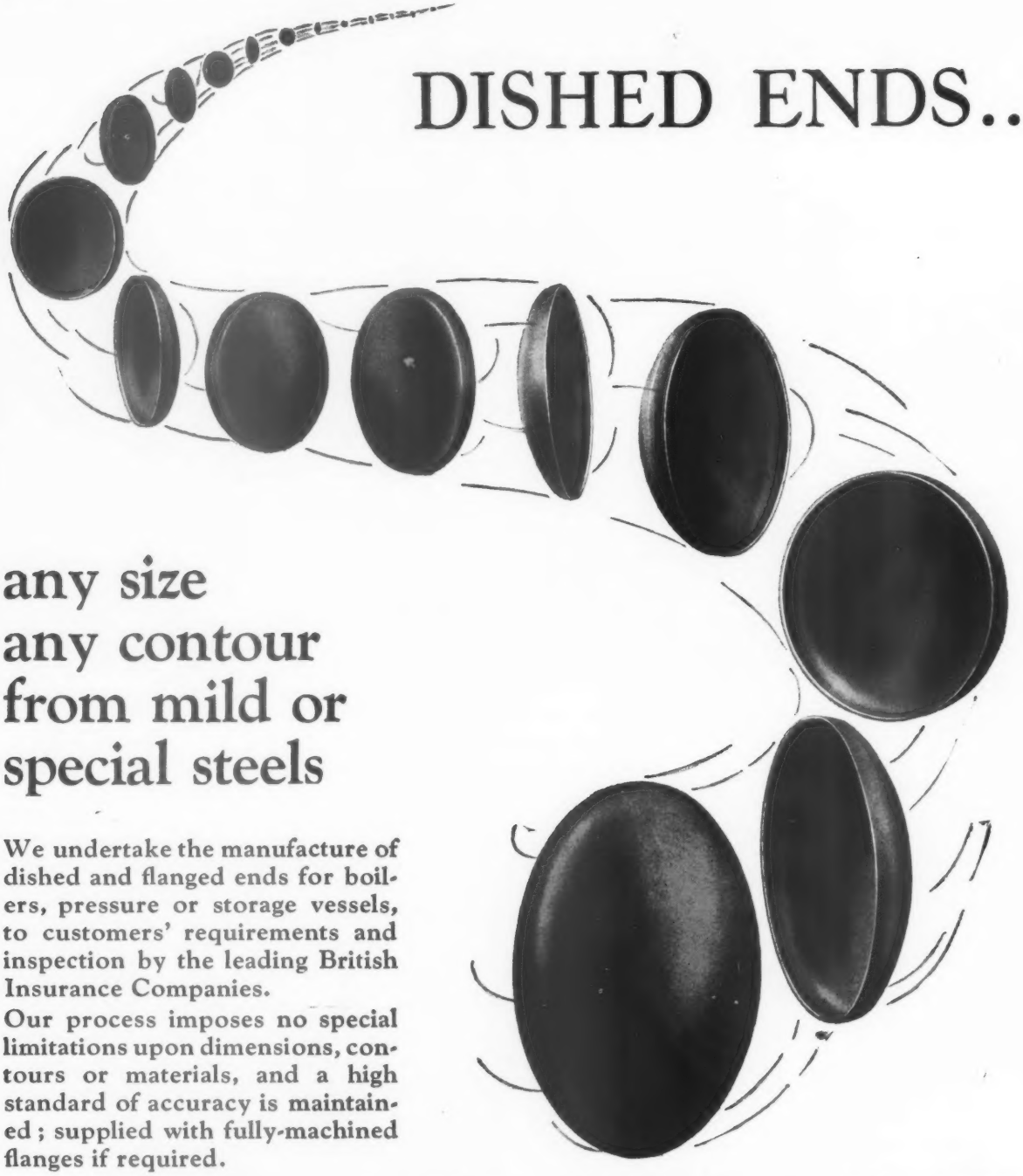

any size
any contour
from mild or special steels

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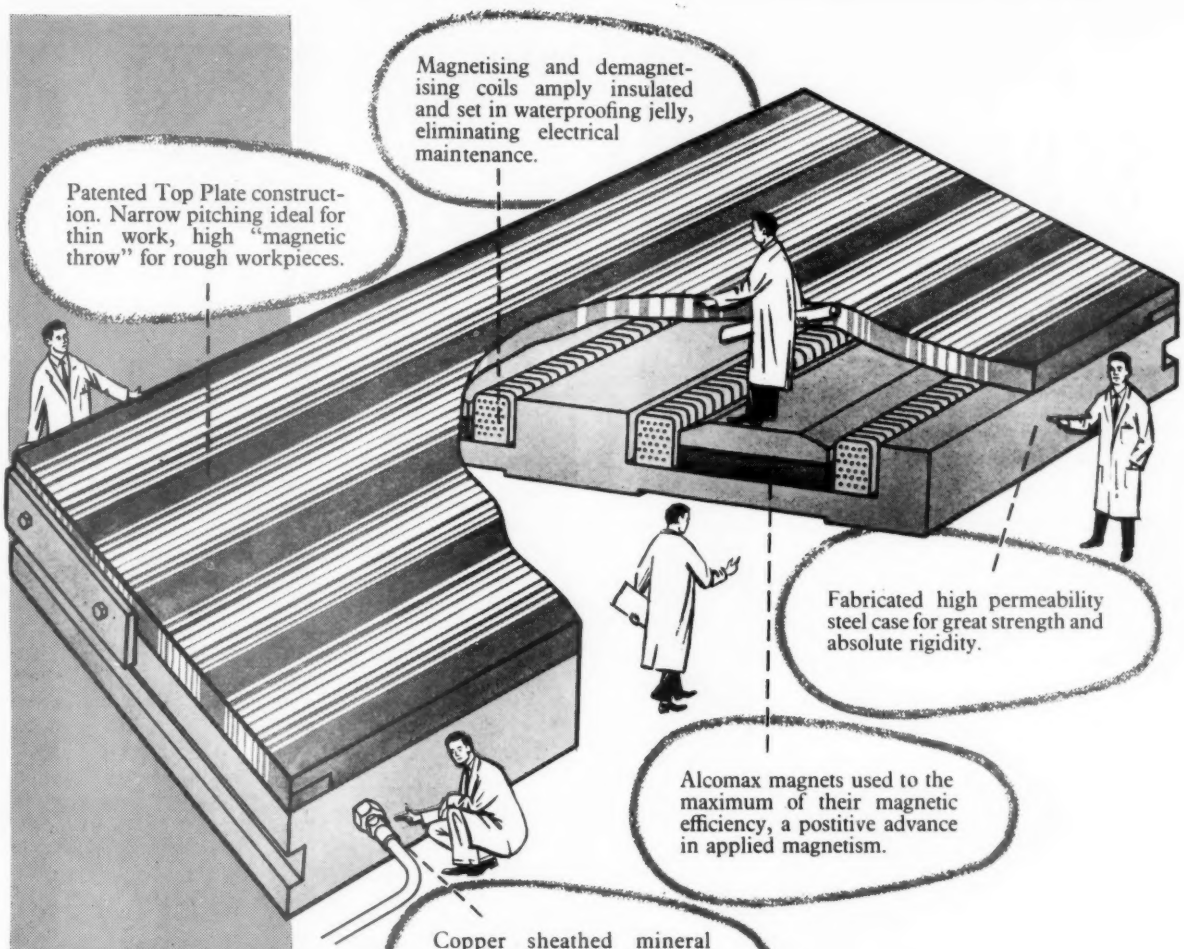

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Complete accuracy—no distortion through heating—no moving parts.

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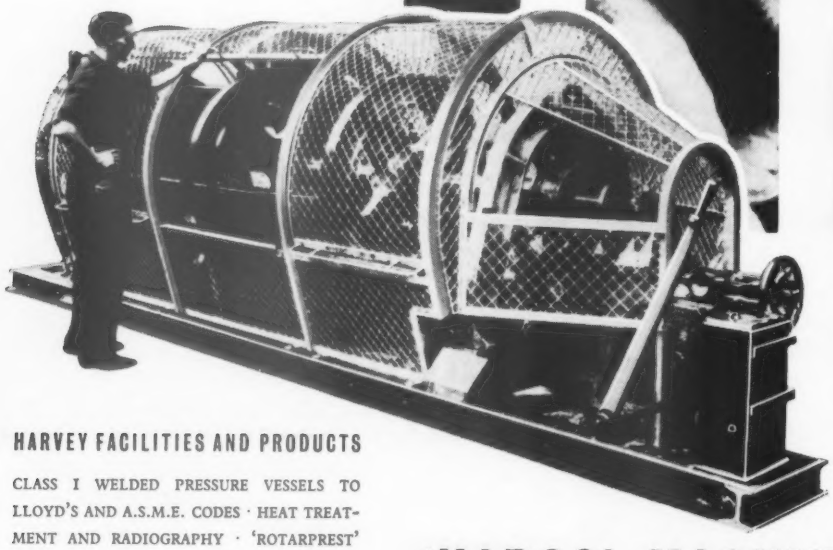
Moving machinery and tools can also inflict serious injury, and it is no less important that these, too, should be securely guarded and fenced.



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'Harco' Machinery Guards are purpose made for every type of machinery, and are constructed to afford complete protection without interfering with efficient operation. They are strongly made from stout wire mesh to withstand vibration and rough treatment, and all 'Harco' Guards fully conform to Factory Act requirements. The complete Harvey service covers advice, design and installation, and List No. 996 shows many types already supplied.

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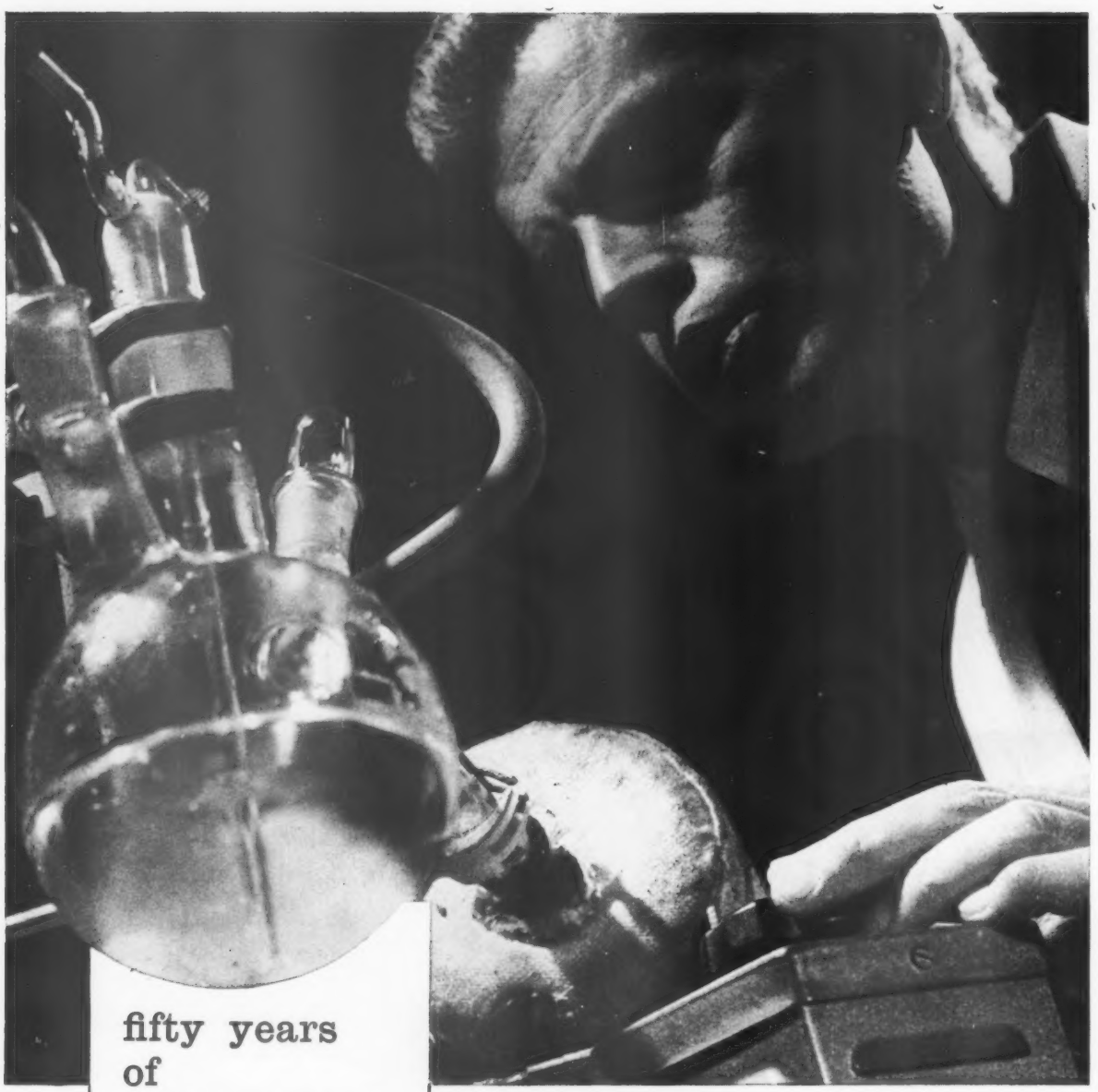

fifty years of looking ahead

THIS year we can look back on fifty years of looking ahead. In 1910 the first two dispersions* of colloidal graphite to be manufactured in this country were introduced by the British unit of the Acheson Organisation. Still extensively used in industry, these products are now supplemented by dispersions of graphite, molybdenum disulphide, PTFE, boron, glass, silver, mica, vermiculite and other solids. Today Acheson dispersions have a thousand and one uses in every branch of industry and benefit boffins and boiler-makers, shipwrights and spacemen, time and motor men, organ makers and means testers, kingpins and needle makers. The Acheson range is many things to many people in most industries.

50 YEARS

Acheson Colloids

LIMITED

(a subsidiary of Acheson Industries (Europe) Limited)

P.O. BOX 12 · PRINCE ROCK · PLYMOUTH · DEVON

ACHESON

**"Oildag" colloidal graphite in oil and "Aquadag" colloidal graphite in water. "Oildag" and "Aquadag" are registered trade marks.*

ALSO ACHESON COLLOIDS CO., PORT HURON MICHIGAN U.S.A. & ACHESON COLLOIDEN N.V. SCHEEMDA (GR) NETHERLANDS

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SLOW—QUICK—QUICK
SLOW

If product flow goes quick, quick slow—then what you need is variable speed. 2400 bottles for gin—Gordon's of course—reach this machine every hour, but there can be 3600. The gin is there, so the machine must bottle faster. How? Turn the handwheel and the Hainsworth pulley and V-belt move to the right speed position automatically. Faster—slower—every few minutes if needed. Bottling, spinning, woodworking, packaging—give your production a tonic, and get the right speed for your need with . . .

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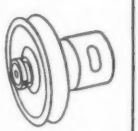
VARIABLE SPEED DRIVES



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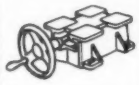
7 sizes available for drives up to 10 H.P.

THE V-BELT
one of 35 sizes will suit your job



THE CONTROLLER
will carry any standard electric motor

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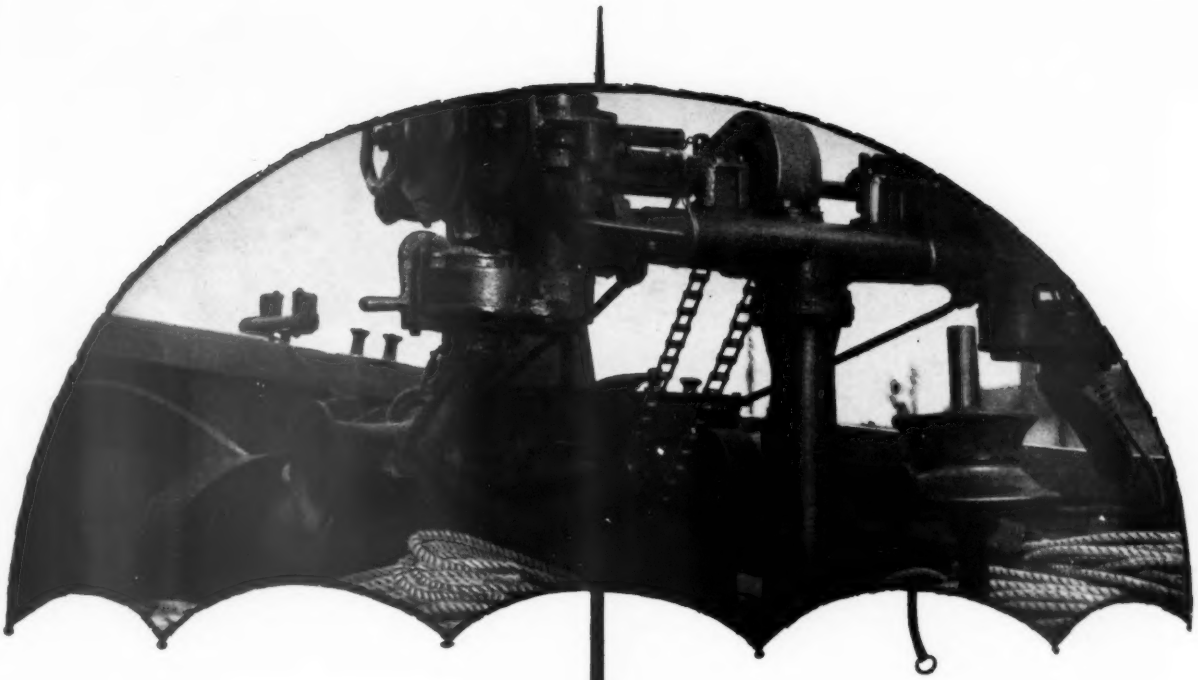
Stocks carried in BELFAST. BIRMINGHAM. BRADFORD. BRISTOL. BURNLEY. CARDIFF. GLASGOW HULL. LEEDS. LEICESTER. LIVERPOOL. LONDON. LUTON. MANCHESTER MIDDLESBROUGH. NEWCASTLE. NOTTINGHAM. SHEFFIELD. STOKE.

LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH



The all weather drive!

For tough, slow-speed drives which must function in all weathers, specify THE COVENTRY MARK 5 CHAINS. These corrosion-resistant all-steel roller chains ensure long trouble-free service under the most arduous conditions. They will replace malleable chains and run on the same wheels.

This rope coiling machine, for facilitating the quick stowage of ropes on fishing vessels, is driven by a Mark 5 chain—an application where the utmost reliability is essential under the most adverse climatic conditions.

THE COVENTRY MARK 5
STEEL ROLLER CHAINS

RENOLD

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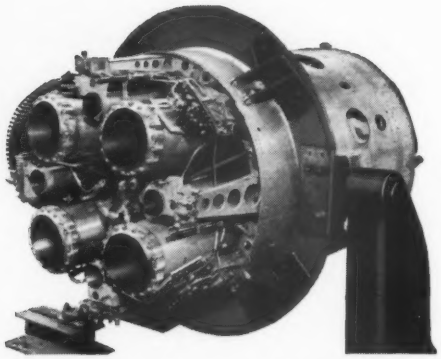
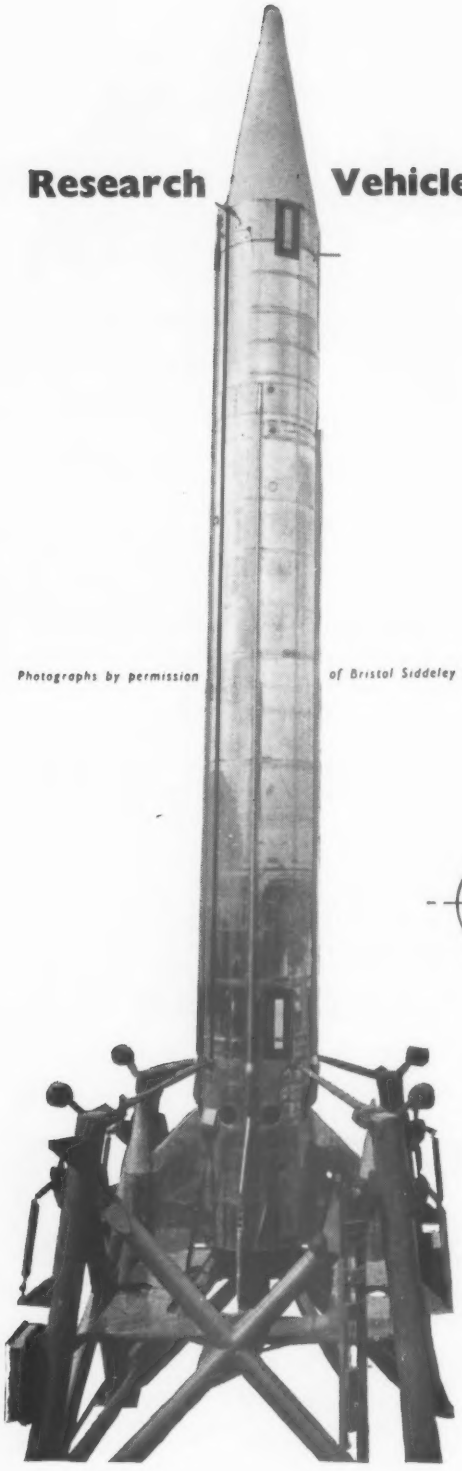


Research Vehicle engines use the Belleville Washer

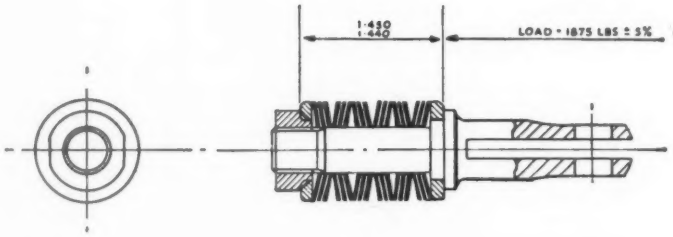
When the Black Knight Rocket roars 150 miles up into space it is guided by the swivelling through an angle of the four combustion chambers of the Gamma engine. An efficient damping mechanism is needed to prevent damage when the limit stop is reached.

Belleville washers provide the perfect answer to the problem.

Belleville washers are solving design difficulties in every industry where resistance to exceptionally heavy loads is beyond the capacity of helical springs and particularly where movement under shock or sustained load must be restricted to very fine limits. Salter technicians can help you. Their services are freely at your disposal.



Photographs by permission of Bristol Siddeley Engines



SALTER

MAKE THE FINEST BELLEVILLE WASHERS

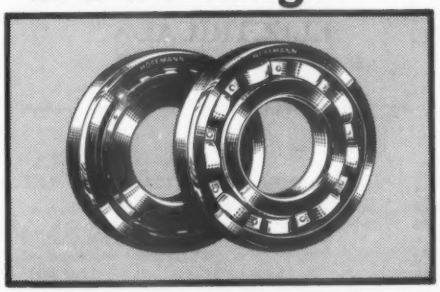
GEO. SALTER & CO. LTD., WEST BROMWICH, ENGLAND. *Established 1760*

At the push of a finger

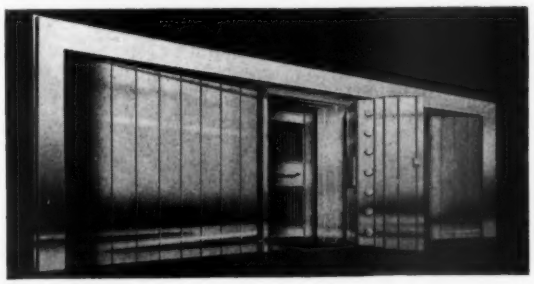
At the push of a finger this massive strongroom door swings safely into position — a pressure of 6 lbs. moves 33 tons, the weight of the door

A CHUBB ACHIEVEMENT HINGED UPON

HOFFMANN Bearings



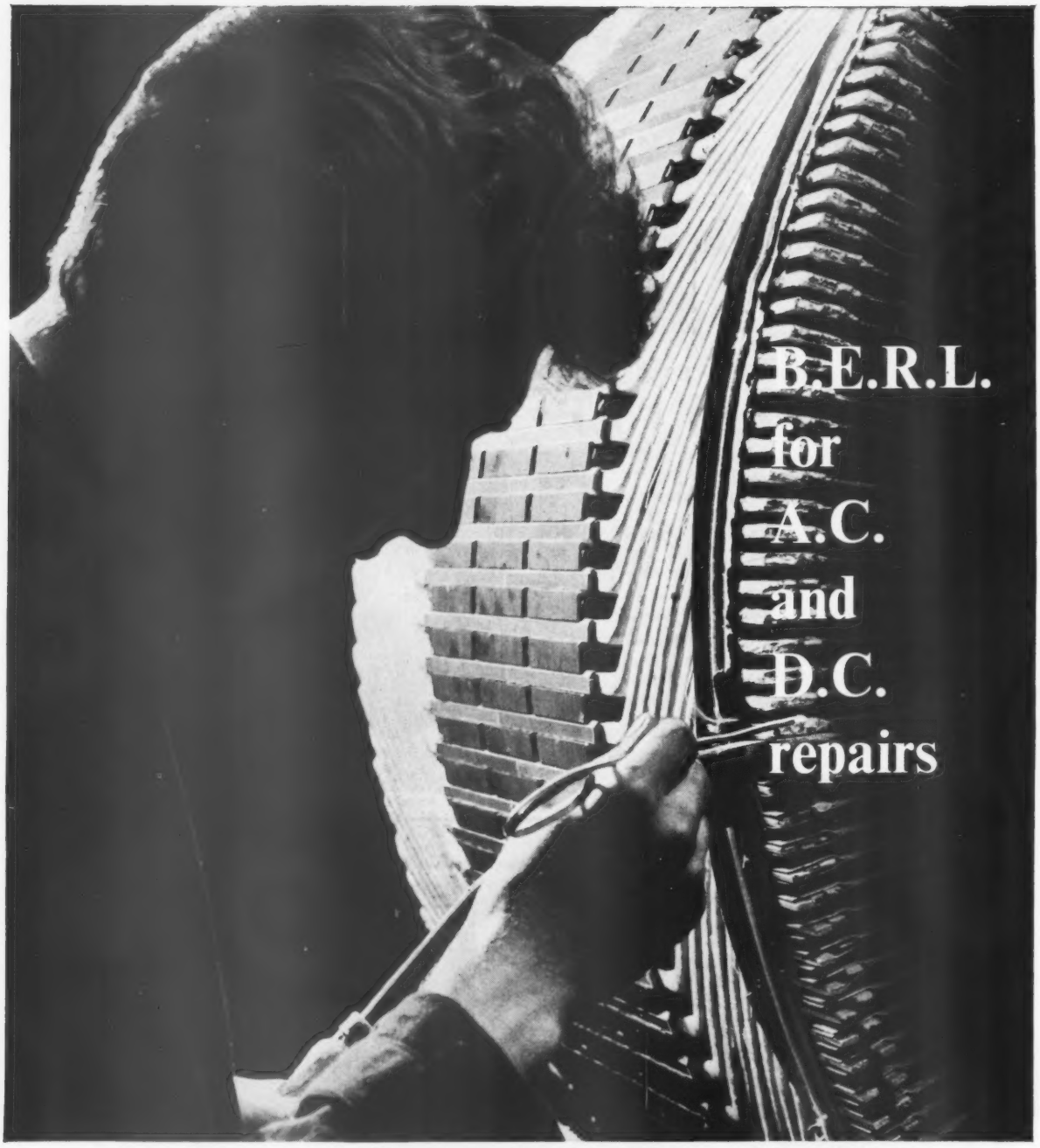
View of strongroom with extended architrave as it will appear when installed.



The door, foremost in design and craftsmanship, incorporates the most up-to-date locking devices and affords a very great measure of protection. But once the multiple locks have been disengaged a child of six can swing the massive doors. Hinged on Hoffmann Bearings, a mere 6 lbs. pressure moves them.

Chubbs sought utmost reliability, utmost freedom of movement, utmost strength: they put their trust in Hoffmann Bearings.

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX



The illustration shows the soldering of the winding to commutator risers of a 1250 kW., D.C. generator armature.

Works at: Bath, Birmingham, Cardiff, Chesterfield, Edinburgh, Glasgow, Hawick, London, Newcastle, Swansea.

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AND ENGINEERING RECORD

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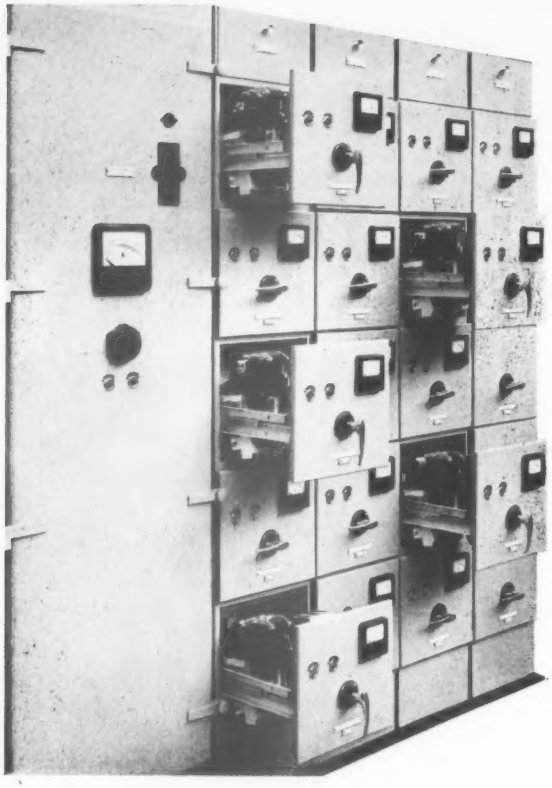
Contributions. The Editor invites original contributions on mechanical subjects. Broadly the aspects covered are the design, materials, manufacture, process, management and maintenance of engineering and industrial plant and machinery. Sketches should be in black ink if possible but the lettering may be left in pencil. Photographs are welcome and so are short notes of practical experience. Payment is made for exclusive contributions. Communications should be addressed: The Editor, MECHANICAL WORLD, 31 King Street West, Manchester 3.



L.S.E. draw-out control gear is made in three standard capacities, for motors up to 12½, 35 and 90 h.p. capacity.

Provision can be made for larger motors, and for incoming and outgoing circuits, special panels, etc.

Standardized but not stereotyped—

L.S.E. CENTRALIZED DRAW-OUT CONTROL GEAR

The advantages of this type of gear should be considered in all cases of works extensions or modifications involving a number of motors. Savings in the costs of supervision, maintenance, installation and cabling may be effected, together with economy in space.

L.S.E. centralized draw-out equipment (ASTA-tested to 35 MVA) embodies a number of outstanding technical features, and is sufficiently flexible in design to enable a wide range of requirements to be met promptly and economically.

Fuller details are given in Publication 232, available from Laurence, Scott & Electromotors Ltd., Publicity Department, 376 Strand, London W.C.2.

LAURENCE, SCOTT & ELECTROMOTORS LTD.

NORWICH, NOR 85A and BRANCHES

Power Horizon

THE sources of electric power in use at the present time do not by any means represent the whole tally. They are highly developed compared with those which have been known almost as long but which have remained little more than scientific curiosities—such, in fact, as the developed sources once were. The time has now come when the others must be further examined for any possibilities they have to offer. The need arises out of the way in which the demand for power is expanding. The rate is so high that natural reserves of fuel, with one exception, will certainly become inadequate by the end of this century. The exception is uranium, which is in process of being established as a major source. In Britain the reserves of coal are fast dwindling, there is no natural oil to speak of and hydro-electric power is limited and for all practical purposes fully developed. It is therefore important to use coal only at the highest attainable economy, to use oil where appropriate, and to continue with pioneering work in nuclear power. The responsible authorities in other countries see the problem in a similar light and as recent surveys in our pages have shown, many of them have nuclear power projects in hand. The degree of urgency with which this work is being pursued varies with the native fuel resources of the different countries. Those with little or none would naturally like nuclear power on a fully extended scale. Those with plenty of natural fuel are not in such haste. The degree of industrialization of each country superimposes, at present, a limit on ambitions in this direction. What is everywhere wanted, of course, is cheap power, for many reasons and including the facility that cheapness gives for transmission over long distances with an acceptable price at delivery. Coal, which not long ago was losing this race, has recently been endowed with improved economy by the new and highly efficient power stations: so much so that the immediate economic prospects for nuclear power have been overtaken. This spurt is highly creditable to the power engineers responsible and comes opportunely, when conservation of diminishing coal reserves is important.

The present civilization, depending upon power for its sustenance, has been initiated by means of the fossil fuels. The radioactive fuels have appeared in time to continue the rate of development but they are not the only untapped source. Others are attracting research and the undoubted result will be a considerable widening of the power field.

LOG SHEET

Style for Assemblers

In the production of high precision gyroscopes and accelerometers for the inertial navigation systems used in aircraft, missiles and other vehicles, it is imperative that no dust particles greater than about 0·5 micron in size, or any excess moisture are present in the assembly area. In the Ferranti factory at Edinburgh these requirements are met by a special air conditioning plant and by precautions which ensure that machined components do not carry particles from the machine shops into the clean areas.

There is a system of double air locks between the machine shops and a special cleaning room which is equipped with ultrasonic cleaners. A second double air lock between the clean room and the air conditioned store room ensures the minimum transfer of air, and hence dust, between the conditioned and non-conditioned areas.

At the front door there is a very long mat for the removal of mud from shoes. After leaving their outdoor clothing in the cloak-room the operatives enter a shoe changing room which is divided by a low bench on which they sit to remove their outdoor shoes and socks. They then swing their feet over that seat and put on special socks and leather shoes similar to carpet slippers, but which are lint free. The operatives then go through two steps of undressing and dressing with special clothing and, at intermediate stages, are subjected to 30 mph blasts of filtered air for the removal of loose particles. After donning the final garments, the only exposed parts of the body are hands and face.

The clothing issued to operatives has been specially designed for this work and is made of lint-free materials. The outer garment consists of nylon boots, worn on top of the special shoes already donned, nylon hat and nylon overalls. Care has been taken in the design of this clothing to ensure that there are no dust traps such as pockets, and that all openings, e.g. wrist, neck and leg openings can be effectively closed. Particular care has been taken with the hat to ensure complete coverage of the hair.

ONE-MAN BENCH.—Originally designed for internal use by apprentices at Baker Perkins Limited, Westwood Works, Peterborough, the workbench seen here is now being produced for schools, technical colleges and training sections in industrial firms. The idea behind the design is that it should give each apprentice a place of his own, where he can keep his tools and carry out his work in his own individual area. The sense of ownership in providing young men with their own workbenches early on in their career has been found to help develop a sense of responsibility

Atlas Computer

Computer engineers of Manchester University and Ferranti Limited are engaged in constructing the first Atlas computer which will be installed at Manchester University and will be working around the turn of the year 1961/62 and will be the prototype for the Ferranti Atlas production models which will cost about £1m. each.

The simple operation of adding a number into the accumulator register, an integral part of many instructions, will be completed by the computer in 0·2 microseconds and more complicated functions of the computer will be correspondingly faster than current machines. A special feature of Atlas will be its ability to switch to another programme if the main programme is held up for any reason. The computer will therefore be in continuous use to deal with jobs which originate with little or no advance notice.

AEI ELECTRON MICROSCOPE.—This type EM6 electron microscope is installed in the Chemistry Department of King's College, University of Durham. The instrument is being used mainly for two research projects involving the study of the electro-crystallisation of metals, oxides and salts; and the ultra fine structure of carbons. The operator is seen observing Bragg reflections in molybdenum trioxide crystals at a magnification of 30,000x

Biscuit Automation

In the new control system at the biscuit factory of Carr's of Carlisle the recipe cards are in the form of a specially designed punched card. There are dozens of these cards, each one corresponding to one of the different recipes from which biscuits are made. Those required for the day's make of biscuits are inserted in the control panel. The recipes wanted are selected, according to demand, by an electronic searcher and stored in the memory of the control panel. The appropriate quantities of different grades of ingredients are then selected automatically and delivered to each mixer.

The distribution and metering of plastic fat, syrup and glucose is done with equipment specially developed for the purpose by Carr's Engineering Department.

The mixing time of the ingredients is time controlled and the dough is tipped into hoppers to be fed continuously into the biscuit-making machines.

Thomas Robinson & Son Limited, Rochdale, are responsible for the new mill equipment and Elliott Bros. (London) Limited for the automatic system.

Guillotine Fabrication

A new fabrication shop added to the Sheffield works of Keeton Sons & Co. Limited, a member of the Firth Cleveland Group, will enable the firm to carry through its declared policy of constructing all future Keetona sheet metalworking machinery to a new modern design in fabricated steel, in preference to cast iron. The first Keetona guillotines to conform to the new practice

were the 6ft, 8 ft and 10 ft × $\frac{1}{4}$ in. guillotines announced last year.

Although Keeton's own foundry has been closed down, arrangements have been made for the casting of components required for the maintenance of existing Keetona models, including the Keetona $\frac{1}{8}$ in. range, which will still be supplied in cast iron.

The new fabrication shop is a precast concrete construction covering a total floor area of 8,000 sq ft. It comprises facilities for flame cutting plate up to 8 in. thick, 20 ft long, and 6 in. wide. The equipment includes sawing, welding, bending and straightening machines, and two 3-ton capacity cranes.

High-nickel Alloys

In September Henry Wiggin & Company Limited will have been operating continuously for 125 years. The character of the business has changed with the times and today the emphasis is very much upon high nickel-containing alloys of complex compositions and produced to even more complex specifications. In order to keep abreast with the needs of the present technical age it has been necessary to increase considerably the company's personnel and, in particular, the metallurgical department which now numbers two hundred people. Similar expansion has been necessary in the production department. The company is in course of modernizing and concentrating its activities on the site at Hereford so that in a few years' time the whole of its activities will be located there.

It is interesting to note that the march of progress in the field of engineering and technological processing is moving very rapidly in the direction of higher temperatures and pressures. Such conditions necessitate the use of new materials which certainly were not envisaged even when the company celebrated its centenary.

The company has maintained its lead in the field of high temperature alloys used for gas-turbines, thus contributing to the outstanding success of British aero-engines. It will soon be in a position to announce yet another member of the Nimonic series of heat resisting alloys with high-temperature properties in advance of anything it has so far achieved. Furthermore these alloys are now finding increasing use in industrial applications on account of their remarkable strength at high temperatures. The new equipment which has been installed at Hereford provides a wide range of forms required in modern engineering practice.

Royal Society Tercentenary

In July the Royal Society, the oldest academy of science in the world to enjoy continuous existence, will celebrate the tercentenary of its foundation. For three hundred years it has faithfully obeyed the injunction of its first charter to promote by the authority of experiments the sciences of nature and useful arts, and never more so than today. The society has carried out this injunction in several ways, chief among them being the publication of new scientific knowledge and the encouragement of scientific research by maintaining high standards in its election of fellows and by granting medals, lectureships and research fellowships only to those of exceptional merit. A typically British institution the society, unlike many foreign academies, is not a Government body, yet the Government freely seeks its advice, which is readily given, on all kinds of scientific matters, including the direction of the National Physical Laboratory.

The patron of the society is Her Majesty the Queen and on November 30, 1959, there were 595 Fellows and 63 Foreign Members. Among its presidents have been: Sir Christopher Wren, Samuel Pepys, Sir Isaac Newton, Sir Joseph Banks, Sir Humphrey Davy, Sir Joseph Hooker, Lord Kelvin and Lord Lister.

A wide and varied programme has been arranged for the eight days of the celebrations, July 18–26, including a government reception for overseas visitors, and visits to universities, and scientific and cultural centres.

LONG-RANGE BELLOWS.—When fully extended this bellows piece is 40 ft long. It has been made for Sir Howard Grubb Parsons & Co. Limited, by the John Bull Rubber Company Limited, Leicester, who specialize in quantity production of bellows for mechanical joints in automobile and general engineering

Rectifier Plant for India

Despite the increasing use of silicon and germanium power rectifiers, the demand for selenium rectifiers continues to expand both in Britain and overseas. This is borne out by the fact that a complete plant for the manufacture of Westalite selenium rectifier elements, has been designed and manufactured in the Chippenham Works of Westinghouse Brake and Signal Company Limited, and shipped in one consignment to India. This quite considerable undertaking was achieved in a period of eight months.

The recipients of the plant are Hind Rectifiers Pvt. Limited, a subsidiary company of Kaycee Industries Limited, of Bombay, who have been licensees in India of Westinghouse rectifiers and associated equipment since 1946, and instrumental in building up Indian rectifier markets to the very large proportions they have reached today. This ever increasing demand for Westinghouse rectifiers in India has made home production desirable, and to this end Hind Rectifiers Pvt. Limited obtained the approval of the Ministry of Commerce and Industry—Government of India, who welcomed the project as part of India's industrial expansion programme.

With this approval behind them Hind Rectifiers Pvt. Limited called

These packing cases are part of a consignment to India containing a complete plant for the manufacture of selenium rectifiers

on Westinghouse to design and fabricate the rectifier manufacturing processes, and then acquired, in the suburbs of Bombay, a plot of land of some 33,000 sq yd on which to build the factory. Personnel from the Indian company were sent to the Chippenham Works of Westinghouse to gain knowledge and experience in manufacturing processes including the latest techniques applied to Westalite selenium rectifiers. They also personally inspected and tested all the equipment prior to packing for despatch. These engineers who will be responsible for both the operation of the plant in India and the furthering of tuition amongst their colleagues, also hold the key to the future development of metal rectifiers and semiconductor devices in India.

Programmed Forging Operation

For what is believed to be the first time in any country, completely automatic forging of steel by pre-calculated programme has been successfully demonstrated in the experimental forge of the British Iron and Steel Research Association in Sheffield.

The forging was carried out by a precision controlled 200 ton press interlocked with a fast remote-controlled, experimental manipulator capable of longitudinal, rotational and lifting movements. Electric controls had been developed for both press and manipulator to ensure fast, accurate, operation and to synchronize the movements of the two machines. During the forging, the press and manipulator were controlled by a programme control unit on which every detail of the schedule of forging operations had been set up. In this schedule, the upper and lower limit of the squeeze for every pass were given, the manipulator feed between strokes was selected and the manipulation necessary between passes was also stored. The control unit signalled instructions to the press and manipulator in the appropriate sequence.

As a consequence, the finished forging in some respects exceeded the best current industrial standards as regards dimensional precision, and even so the job was accomplished twice as fast as the best skilled forging crew would be capable of doing. Even faster working will shortly be practicable.

The forging schedule was calculated in advance, from a theory of the change in shape during forging which had been worked out in the laboratory.

Planned Lubrication

Industry can frequently effect remarkable savings by the careful and scientific planning of lubricating and production oil needs. The large oil companies employ experts whose job it is to carry out surveys at their customers' plants on request. A good example of such a survey is one which was carried out some two years ago at Hopkinsons Limited, Huddersfield.

Hopkinsons, who manufacture a wide range of power station and factory equipment, including high pressure valves, centrifuges, boiler mountings and soot blowers, have over 500 items of machinery in their works. The survey was carried out by Wakefield-Dick Industrial Oils Limited and revealed that 29 different grades of lubricating and production oils, from 15 different manufacturers, were in use. After a careful study of the requirements of each machine, the oil company recommended a range of 14 oils which would efficiently perform the functions of the existing 29.

Hopkinsons approved the recommendations which included a complete reorganization of the oil store. Here bulk storage tanks and pumps of Wakefield-Dick's manufacture were installed. This made it possible for seven of the oils to be delivered by road tanker rather than in barrels. Not only did delivery in bulk make it possible for the oil to be supplied at a lower cost, but considerable further savings resulted from the attendant reductions in handling and paper work.

Cutting and lubricating efficiency and, therefore, the quality of the finished product, was not sacrificed in the desire to reduce the number of grades in use. If one of the specified bulk grades proved unsatisfactory for a particular job during the initial trial period, another was substituted. In many cases, however, the new grade was more suitable for the job than the old.

After twelve months working of the new system, a substantial saving in cost was recorded in the demand for oil alone, despite an increase in production. This cannot be attributed to the running down of stocks of discontinued oils, as figures so far available for the current year indicate a further saving.

Terylene V-belts

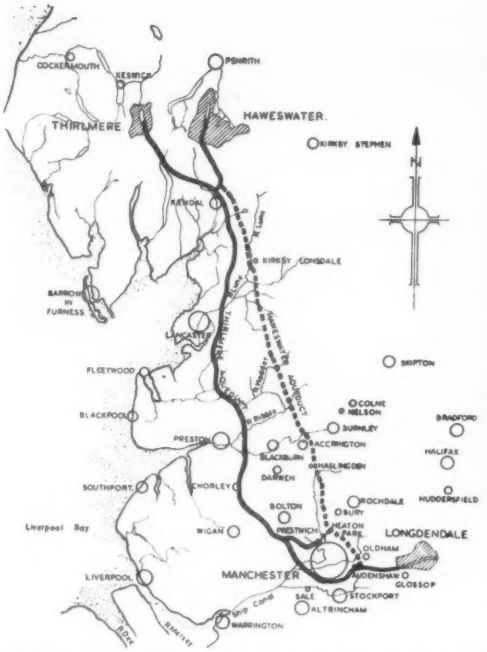
Important economies have been effected at a chemical works in the North-East on one of the largest V-belt installations in the world. Each of a series of compressors, formerly driven by 24 rayon reinforced V-belts, is now being successfully operated by only 14 Terylene reinforced V-belts manufactured by Turner Brothers Asbestos Company Limited, This substantial saving in installation costs has been made possible by the non-stretch properties, dimensional stability and matching characteristics of the new belts.

At Bonnybridge Generating Station three Turners V-belts have been operating continuously for over two years after replacing seven standard rayon belts on a $7\frac{1}{2}$ hp motor drive to a Mavor & Coulson conveyor capable of moving 60 ton of coal per hour. They have required no adjustment or maintenance and have already lasted twice as long as any set of seven V-belts used previously.

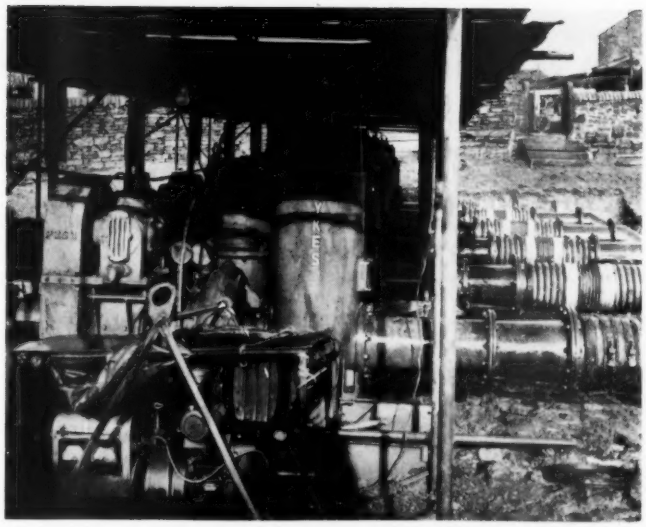
Hydro-electric Plant in Spain

Two 32-MVA waterwheel alternators have been supplied by AEI Heavy Plant Division to Fuerzas Electricas del Noroeste s.a. for a new hydro-electric power station on the River Eume, in north-west Spain, for supplying the 132-kV network in Galicia.

Eume, near Corunna, is the latest addition to a group of hydro-electric stations in north-west Spain which is helping to keep pace with the demand in that region for electric power, estimated to be growing at an annual rate of about 8%. Associated Electrical Industries Limited has supplied generators, transformers, switchgear and control gear for a number of these stations, the largest of which to date is that at Los Peares (187·2 MVA), commissioned in 1955.



The map shows sources of supply and aqueducts to Manchester



"Univac" priming equipment enables these Sykes UVS12 centrifugal pumps to operate continuously on snore. The suction branches are sealed to prevent pollution

Besides supplying the province of Galicia, these stations are providing power for Portugal, France, and central Spain.

The power station at Eume is some 2½ miles downstream from the dam. Water for the 37,500-bhp Boving turbines is taken through a tunnel and then fed into the penstocks. In this way, because the bed of the gorge slopes steeply, a greater working head is obtained than if the power station were placed close to the dam. The dam is of the modern cupola type and is 338 ft high.

In addition to the generators, rated at 32 MVA 600 rpm, 0·85 power factor, AEI has supplied to the Eume power station two three-phase 32-MVA generator-transformers to step up the voltage to 132 kV for distribution; 132-kV circuit-breakers of the "Shuntarc" type, with pneumatic operation; and all control gear for the generator and station auxiliaries.

Canteen Heating

A canteen is only occupied during lunch and tea break and that is the only time it needs to be heated. The alternative to having to keep the room always warm has been reached in the new canteen of Conatus Industries Limited at Walton-on-Thames by the use of infra-red heaters which are switched on only a few minutes before break.

Ekco "Firestreak" 750W units are employed, mounted on the walls, with 1500W "Twinstreaks" suspended from the ceilings in a line down the centre of the canteen.

Aqueduct Reconditioning

Work was started in 1958 on reconditioning the Thirlmere aqueduct which normally supplies 50 million gals. of water daily to Manchester. The aqueduct, completed in 1894, is some 96 miles long, of which 45 are pipeline, 14 are in tunnel, and 37 are of cut and cover construction.

During the early stage of planning the scheme it was apparent that a reliable pumping system capable of handling 20 million gal daily together with the highest possible priming efficiency would be required. Any failure of the pumps due to loss of priming would result in the water level overtopping the bulkhead and with men working in sections of, at times, almost one mile in length, considerable danger could exist in the event of such a failure. The standard pump finally selected was the Univac type UVS12, a 12 in. pump of 3500 gpm capacity at 32 ft total head in a self-priming range produced by Henry Sykes Limited and which depends for its self-priming characteristic on the use of an ancillary vacuum pump.

The work is being carried forward in a series of stages using temporary bulkheads dividing the aqueduct into sections, the largest so far being a 5800 ft length involving a suction lift of 13 ft and total head from all causes of 38 ft, four pumps being operated from one standby unit to handle 12 to 15 million gal flow of the aqueduct at this point.

The sections are sealed by two bulkheads of steel angle construction with rubber seatings and are pin jointed to allow them to be fixed against the side walls of the aqueduct by an adjustable cross strut, in effect an Acrow trench prop. In this frame is then inserted two steel plates which form the lock, the plates carrying eccentric levers which hold them tightly against the rubber seatings of the frame, forming a watertight bulkhead. With the sealing complete the contained water is pumped out with a Sykes UVS6 self-priming centrifugal pump.

Each section is equipped with three Consolidated Pneumatic type 365-RO-2 power vane compressors

Avoiding Component Failure by Correct Design

Heat treatment and service conditions

By A. G. GARDNER, A.I.M.

THE importance of good design in modern machinery cannot be overemphasized. The degree of competition which exists at the present day demands the required strength and performance at minimum cost. Good design is the first and basic step in meeting these requirements since it is recognized that design is often a more questionable factor than the material used when service failures must be eliminated.

Correct design based on an understanding of the operating stresses and possible stress concentrations can often result in considerable economy. The aircraft industry was probably the first to appreciate the advantages of precise design, since the potential reduction in weight and increase in reliability were essential to its success.

Sound design is achieved to a large extent by determination of the stresses present in parts under operating loads. This information has made it possible for designers to eliminate material in low stress regions and to relieve local stress concentrations.

The failure of a part usually occurs in a region of localized stresses or stress concentration. The proper distribution of stresses—a matter of paramount importance if mechanical failure is to be avoided—is obtainable largely through the physical shape and position of the parts to be loaded. Designers have, therefore, found it worth-while to pay attention to stress concentration or stress raisers, where the local stresses are much higher than the average, and this is particularly true under conditions of high stress and fluctuating load.

Stress raisers can result from a number of causes. Many are brought about by poor design in the form of notches, sharp corners, abrupt changes in section, inadequate fillets, grooves, re-entrant angles, keyways, oil holes, screw threads and thin fins. Some are more insidious types that result from poor execution of design such as inferior machining, tool marks, scratches, quenching and grinding cracks, undercutting adjacent to bolt heads or flanges and sharp inspection stamps on highly stressed surfaces.

It is the purpose of this article to explain how correct component design can minimize stress which can arise both during heat treatment and in subsequent service. It will also be shown how quenching technique can influence internal stress, the presence of which can markedly reduce service life.

Component design for minimum operating stress

Most design calculations are made on the basis of three simple formulæ:

(1) For direct stress $S=P/A$

where P=load

A=area

(2) For bending $S=\dfrac{M}{I/C}$

where M=the bending moment

I/C=section modulus in bending

(3) For tension $S=\dfrac{T}{J/C}$

where T=torque

J/C=section modulus in torsion

These formulæ apply only where there is no change of section for a considerable distance axially (of the order of the diameter or depth dimension). In nearly all machine parts, however, the minimum section occurs at a region of changing section, which as shown in Fig. 1 introduces a redistribution of stress such that an increase of stress or 'stress concentration' occurs near the surface. The 'stress concentration factor' is defined as:

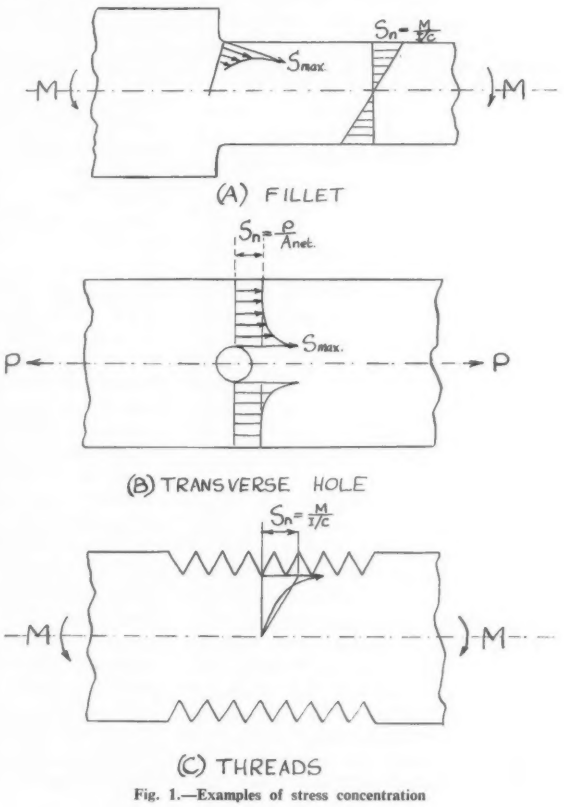


Fig. 1.—Examples of stress concentration

$K = S_{max}/S_n$ where S_n = nominal or average stress
The nominal stress is calculated by means of a simple formula usually based on stress per unit area.

Factors of stress concentration are determined in numerous ways: by mathematical analysis, photo-elasticity, strain gauges, brittle materials and coatings, etc.

It is not, of course, practicable for a machine to be built without some localized stresses being present but on the other hand no efficient machine part can be designed if stress raisers are ignored. Even with the best possible design, however, stress concentration cannot be entirely eliminated. For example, threads and keyways introduce stress concentration factors of two or more.

Some of the commonest examples of stress raisers will now be dealt with in the examples which follow. An understanding of the principles underlying these basic types should assist with other design problems which may be encountered from time to time.

Sharp changes of section should be avoided whenever possible and deleterious effects can be reduced by using as generous a fillet as possible (Fig. 2). An increase in the radius of notches and fillets is a simple way of improving the distribution of stresses.

The larger fillet in Fig. 3b has a lower stress concentration than the small fillet in Fig. 3a. The stress concentration of Fig. 3c with a re-entrant fillet is large but less than a square shoulder would produce. Designs of this type can be used to good advantage where there is not enough space for a well-rounded fillet. Fig. 3d shows how a jog resulting from poor machine work considerably increases the stress that the designer thought he had guarded against by the fillet specified on the drawing.

Similar considerations to the above apply to the effect of root radius on stress concentration factor of gear teeth and Fig. 4a illustrates a normal fillet with a stress factor of 3·5 which can be reduced to 1·7 by allowing a full radius at the root.

It is possible to use stress concentration to defeat itself by placing several stress raisers together, as a single notch is more harmful than several notches close together. This is illustrated in Fig. 5 which shows relieving grooves at (a) resulting in a more even stress pattern.

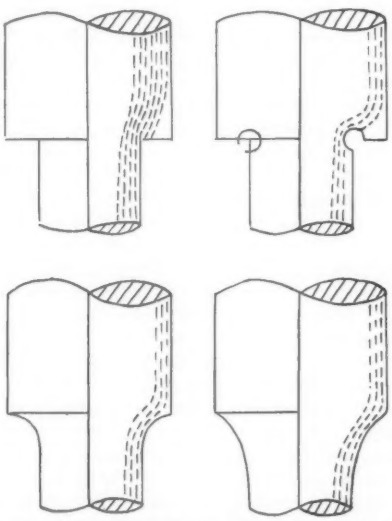


Fig. 2.—Improving the distribution of stresses by an increase in the radius of notches and fillets

The case of a sudden change of section already quoted can be dealt with in another way by means of a relieving groove to reduce the notch effect (Fig. 6). The technique of cancelling out stress concentration need not necessarily employ holes or grvooes. Fig. 6 shows tangential unloading notches which have been impressed in the surface of the component on either side of radial holes which on their own would constitute vulnerable areas of stress concentration.

Oil holes represent critically stressed areas on certain components and on crankshafts in particular. The stress concentration due to the oil hole can, however, be reduced by a suitable inclination of the normally radial hole as an alternative to the cancellation method just described.

Designing for heat treatment

Many of the points given above concerning stress raisers apply to heat treatment stresses as well as to those arising during service and further examples of correct design are therefore given under this heading. Heat treatment must also be carried out in such a manner as to keep internal stresses to a minimum and the underlying principles and recommended technique will be discussed.

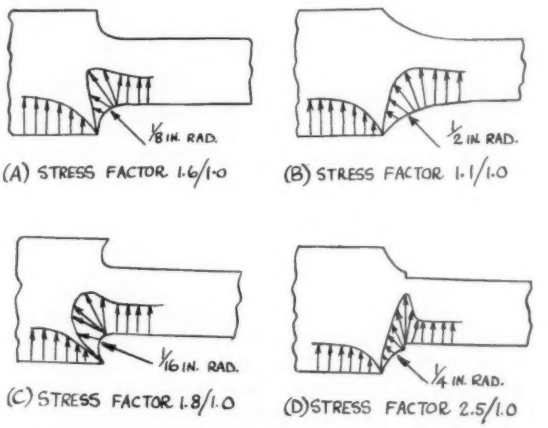


Fig. 3.—The effect of radii and machining marks on stress concentration

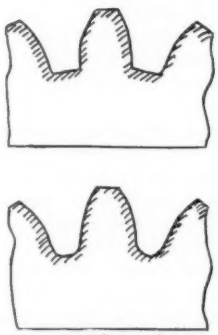


Fig. 4.—Effect of root radius on stress concentration factor of gear teeth

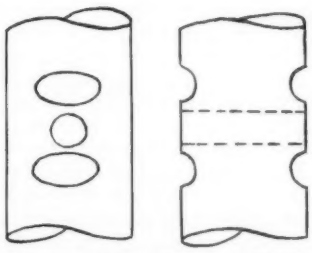


Fig. 5.—Tangential relieving grooves in tension rods at radial hole edges

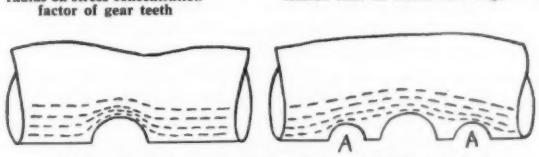


Fig. 6.—Reduced stress concentration by relieving grooves at A

Internal stresses induced during heat treatment may be great enough to exceed the strength of the material and in such instances cracks or complete fracture would occur. Alternatively, although the internal stresses may not be great enough to cause failure during heat treatment, they can represent the greater part of the material strength and failure could then occur in service under a relatively light load.

The process of heating or cooling a piece of steel is associated with temperature gradients and consequent volume-change gradients. The latter can also occur as a result of structural changes and the overall result can be the generation of high residual stresses. The temperature gradients occur because cooling is not even throughout the mass of a part which is being quenched. These gradients depend largely on the size and shape of the piece, in other words on the design. The aim, therefore, should be to design in such a manner as to keep temperature gradients to a minimum.

The ideal condition from the design point of view is attained when the entire piece can be heated and cooled at approximately the same rate during the quenching operation. This can rarely, if ever, be achieved, but much can be accomplished by careful study. The greater the temperature difference between any two points on or in a given part during quenching, and the closer these two points, the greater the internal stress and, therefore, the poorer the design.

A component taken from the furnace in readiness for quenching is at a uniform temperature providing it has been given sufficient soaking time. As soon as quenching begins the temperature is different in almost every part of the component.

This arises because of two factors:

(1) The heat capacity of some portions is greater than that of others simply because there is more metal in one portion than another. For example, the point of a tapered pin will cool faster than the heavier section because there is less heat to be dissipated for the amount of cooling surface.

(2) The surface shape affects the cooling rate. Fig. 7 illustrates a shape which, although of uniform thickness, will not cool uniformly. Protruding corners, such as at A, are cooled from three sides so that the extreme corner gives off heat from an area approximately seven times as great as that through which it is receiving heat. An edge such as B is cooled from two sides, and the ratio of the area through which it is giving off and receiving heat is 3:1. A point on the flat side such as C, receives heat from one side, and gives it off from the other. Here the cooling and heating areas are approximately equal. At the re-entrant angle D, heat is being supplied to the surface through an area three times as great as that through which it is being dissipated, and this point will cool slowly. Sharp re-entrant angles are always objectionable since it is impossible to obtain uniform cooling during quenching in the immediate vicinity of such an angle. Vapour pockets frequently form in the corners and produce soft spots. Invariably the cooling rate at the point of an angle will be slow because the area is so inaccessible to coolant. Consequently, heavy internal strains are set up at a point which will certainly be subjected to stress concentrations in service. In fact, it can easily happen with an indifferent design that high local stresses induced in service are concentrated at points already weakened by internal stresses produced during hardening.

The foregoing has been concerned with the manner in which internal stresses can occur during cooling. It is next necessary to consider certain features of design which can be used to minimize heat-treatment stresses, and this is best achieved by quoting some actual examples.

There are various ways of overcoming the problem of sharp re-entrant angles in large and heavy sections. Holes can often be provided through a heavy portion in order to balance the weight of the metal throughout the component. At the point of the re-entrant angle a generous fillet can be provided or, alternatively, undercutting can be adopted to provide a radius while still obtaining the effect of a sharp corner. The latter method has little to recommend it from the point of view of quenching stresses, but in service the concentration of stresses, such as would occur at a sharp corner, is avoided.

As regards keyways, a round cornered form is to be preferred. Two keyways cut on opposite sides of a ring almost invariably cause it to become oval on quenching. The section can be balanced by cutting two further keyways at right angles to the first pair and thus preventing warping.

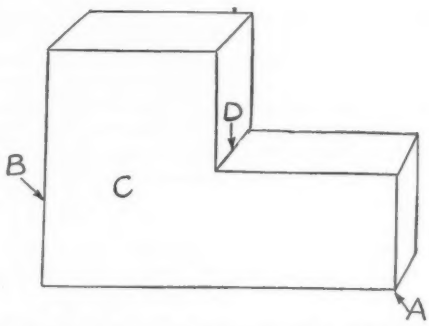


Fig. 7.—Shape of uniform thickness which will not cool uniformly

Keyways in a splined shaft may cause distortion in quenching. Unless designed with ample section, a shaft with a keyway has less stiffness than one carrying keys integral with the shaft. To minimize distortion in quenching, it is advantageous to have more than one integral key. These keys are spaced about the shaft to facilitate equal cooling and to balance the section.

When heat treating small diameter twist drills joined to Morse taper shanks, there is a tendency for stress concentrations at the joints to cause fracture. This can be avoided by providing a more generous fillet.

When heat treating heavy forgings, large radii or fillets should be provided at sharp changes of section so as to minimize the danger of cracking. As sections increase in size or as shapes become more irregular, the possibility of quench cracks increases. It is recommended that liquid quenching be normally restricted to parts 10 in. or less in diameter or thickness and, where possible, forgings more than 7 in. dia should be bored. The effectiveness of quenching a bored forging depends to a great extent on the ratio of wall thickness to the diameter of hole and the length.

Carbon steels are not recommended for complicated shapes where distortion must be avoided. For complicated shapes water quenching should not be used and a less active quench employed which reduces the temperature gradient considerably during quenching. Some parts

which have very abrupt changes of section are almost impossible to harden, but there is a certain amount of latitude when oil hardening or air hardening steels are quenched because of the lower temperature gradients. Thus a design which is satisfactory when the part is made from an air hardening steel, may be quite unsuitable if a steel requiring a more drastic quenching medium is substituted.

In steel that has been carburized, the volume changes that cause internal stresses are further complicated by the fact that the high carbon case changes much more in volume while passing through the transformation range than does the low carbon steel in the core, and the temperature at which the change in volume occurs varies greatly with the content of carbon and alloying elements. In these cases it is necessary to carry out trials to determine the best combination of case depth and method of hardening which will leave the component in the most favourable stress condition to meet service requirements. Normally the volume increase that occurs when the case hardens is greater than the increase in the core. The carburized case is then in a state of compressive stress and this condition makes it possible for the part to sustain a higher external load, which generally tends to create tensile stresses, than if compression stresses were not present.

Compressive stresses generated in the case of a carburized component are opposed by equivalent tensile stresses in the core. If the cross section of the core is insufficient to support the compressive stresses in the case, then failure occurs in the core. This failure sometimes takes place as transverse cracking through the core and in other instances by cracking between the case and the core, causing a separation at the bottom of the case. As smooth a transition in hardness as possible should be aimed for from case to core in order to avoid stress concentration at the boundary.

When the maximum possible has been done as regards the design of a component, there still remains certain quenching modifications which will assist in reducing the chance of distortion or cracking, and these will now be dealt with.

Special quenching methods for minimizing internal stresses

Although water quenching allows the use of lower hardenability steels, this can only be employed on small parts of regular shape where there is no great danger of distortion or cracking. Oil hardening lessens the risk of internal stresses, but higher hardenability steels have to be used. Agitation increases the quenching rate but helps to minimize distortion by giving a more uniform quench.

Various fixtures are now used to control size and shapes during quenching and the modern gear quenching machine is an excellent example of this trend. It should, however, be ensured that the steel used possesses sufficient hardenability to harden even where the component is in contact with the fixture.

There are several other techniques which have been developed in order to minimize distortion and cracking during the quench by decreasing the temperature gradients and these will now be briefly mentioned.

(1) A more uniform quench can be obtained if, for example, holes or keyways are plugged before heat-treatment so that the entire part tends to cool at about the same rate.

(2) *Delayed quench.* The steel is air-cooled before quenching in a liquid bath. The permissible time for which a steel may be air-cooled without loss of hardening prior to quenching will depend on the composition, but by this method temperature gradients are less severe since quenching is carried out from a lower temperature.

(3) *Austempering.* Here the component is quenched in a bath maintained between about 400° and 520° C and kept in the bath until transformation is complete no further tempering being necessary. This method is mainly of use for small sections of carbon steels, since the holding time for highly alloyed steels becomes too long to be a commercial proposition.

It should be mentioned that medium carbon steels heat-treated in this way have lower yield points and generally lower toughness than fully hardened and tempered steels at the same hardness.

(4) *Interrupted quench.* The steel is first quenched in a liquid bath, usually water, but is removed from the quench before it is completely cold. The interval during which the component is immersed in the bath may be measured on a basis of time or temperature. The part is then transferred to a milder medium, generally oil or air.

This method has been successfully applied with such components as shafts, gears and connecting rods which have both light and heavy sections. However, more control is involved than with martempering since fracture can occur if the part is left in the first quench too long.

(5) *Martempering.* In this process the steel is quenched into a salt or hot oil bath maintained at a temperature slightly above that at which martensite is formed (the Ms temperature).

This technique depends on the fact that cracking and distortion in normal quenching result to a large degree from the temperature gradients existing in the piece while the martensite is forming. Internal stresses are minimized in martempering because the temperature throughout the component is made uniform just before martensite formation starts. The steel is, therefore, allowed to remain in the bath until the temperature has become practically uniform throughout the part: generally a minimum time of 5 min per inch of section. The steel is afterwards removed from the bath and allowed to cool slowly, normally in air, to form martensite.

Critical sections usually require a somewhat higher hardenability steel than would be needed for an oil quench.

Service conditions

Finally, service conditions should be considered. These may operate so as to affect adversely the properties of the material. Alternatively, the stresses in the material may exceed the allowable design values. Such examples as the loosening of a threaded connexion, the hardening of gaskets and shock-absorbing devices because of ageing, and other factors which may affect clearances, change the rates at which loads are applied. This may result in parts being subjected to impact or repetition of loads which they were not designed to withstand. The existence of such conditions can often be established by examination of a fractured component. When this indicates an impact failure or a progressive failure at a few alternations of stress, it is advisable to investigate the possibility that other parts of the machine may have become loose or distorted, thus throwing an excessively high load on the part that failed.

Another cause of premature failure can be temperature rise resulting from unusual operating conditions. These may cause failure on account of reducing the strength by an annealing action bringing about a change in the structure of the metal. This type of damage is sometimes detected by measuring the hardness but a microcsopic examination is often also necessary. Low temperatures are less likely to cause trouble but high stresses may sometimes arise by the unequal contraction of dissimilar metals with different coefficients of expansion.

Mechanical defects, such as scratches, notches and other marks on the surface are stress raisers and will lower the resistance to failure from alternating stresses.

Conclusions

It is hoped that the foregoing will serve as some guide in the avoidance of premature component failures. The point which this article has tried to emphasize is that the majority of service failures are not due to inadequate strength of the material but to poor design on the drawing board, or to the manner in which the component has been produced either during machining or heat treatment.

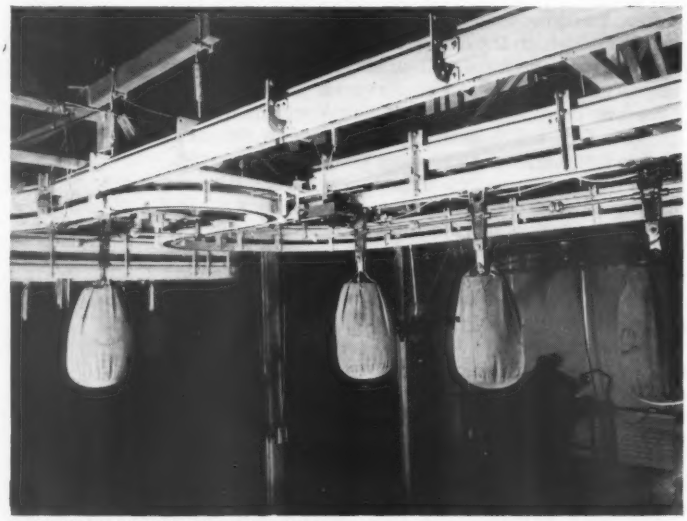
New English Electric Motors

A new range of totally-enclosed fan-cooled motors which are smaller, lighter and cheaper than existing motors of the same type is announced by The English Electric Company Limited. The dimensions of the new motor are exactly the same as the C-type ventilated motor (British Standard 2960) and the two types are, therefore, interchangeable.

The new motors, called Type-D, have outputs up to 100% greater than existing motors of the same size, Type-B. For example, a 40 hp Type-D motor is now manufactured in the same frame size as the previous 20 hp Type-B.

The greater outputs have been achieved by allowing for a temperature rise of 65° C above 40° C instead of the existing 55° C. This results from the use of Class-E insulation instead of Class-A.

These new motors are designed for wide industrial application, particularly where there is dust and dirt in the atmosphere. Typical applications are on machine tools, pumps, compressors, in the chemical, oil, plastics, rubber, steel, mining, gas, food and agricultural industries. Special versions, having internal and external anti-corrosion treatment, will be produced for the chemical and gas industries.

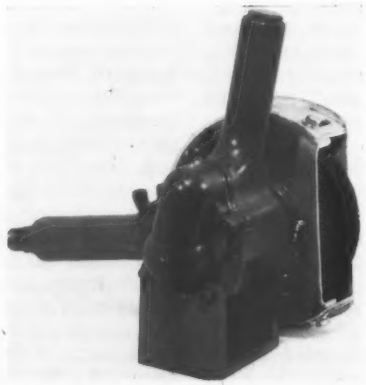


DUAL-DUTY CONVEYOR.—This dual-duty conveyor has been developed by Teleflex Products Limited, Basildon, Essex, with a standard production automatic preselective device which conveys work trays at a rate of 15 per min, each tray having the facility of being automatically transferred from one moving conveyor to another in a preselected sequence. Also each work carrier can be fitted with a device to enable functions such as automatic off-loading to take place at a predetermined destination. The complete system is flexible in its design and can be planned to negotiate horizontal and vertical bends thus fitting into any factory production layout

Vertical Cochrane Boiler

A vertical boiler was recently introduced in the well-known range made by Cochrane & Co. Annan, Limited, Newbie Works, Annan Dumfriesshire. Known as the Series II it is fitted as standard with a specially turned, forced-draught, pressure-jet burner made by the Brockhouse Heater Company Limited, which is tested and set for optimum combustion during steam testing at Newbie Works before despatch. Though the Series II boiler is oil-fired in this way it is readily convertible to coal firing should this be necessary.

The new boiler is of multi-pass design giving a guaranteed efficiency of over 80% on the gross calorific value of the fuel. It is available in ratings from 1750 to 10,000 lb per hr from and at 212° F. An early extension of this range is planned by the makers.



The Consolidated Pneumatic 3190M bench grinder

Pneumatic Bench Grinder

A new air-operated grinder for mounting on work benches introduced by the Consolidated Pneumatic Tool Company Limited, 232, Dawes Road, London SW6, is known as the 3190M and has a 6 in. dia wheel with a width of 1 in., the free operating speed being 4500 rpm. Overall height is $9\frac{1}{16}$ in. and the weight, including guard, 12 lb. The air inlet connexion is $\frac{1}{2}$ in. dia with male B.S.P. thread.

Power is developed by a vane type motor which has a constant speed governor to maintain the wheel at the most efficient cutting speed from no load to full load, eliminating the possibility of over-speed when running free. A heavy valve spring and loose fitting valve prevent the valve from being jammed by foreign matter and a neoprene O-ring gives a leakproof valve seal.

The drilled baseplate enables the grinder to be attached to portable compressors as well as to the bench.

Earth Leakage and Earth Fault Protection—VII

Earth-leakage Trips

By J. L. WATTS

THE Electricity Regulations of the Factories Acts call for earth-leakage protection where the impedance of the earth-fault loop is too high for protection against earth faults to be effectively provided by excess-current protective devices.

Current-balance earth-leakage circuit-breakers

The Quarries (Electricity) Order, 1956 requires the fitting of effective means of automatically cutting off the supply from a circuit if the leakage current to earth exceeds 15% of the rated current for which the circuit is designed (or 5 amp, whichever is the greater) for all circuits operating on more than 650 volt a.c., and for portable apparatus operating on more than 125 volt a.c.

The I.E.E. Regulations require that, in all cases where the impedance of the earth-fault loop is so high that, in the event of a fault of negligible impedance from a phase conductor to adjacent exposed metalwork on the consumer's installation, the fault current will be less than three times the current rating of the fuse, or 1½ times the setting of the overload circuit-breaker, an earth-leakage circuit-breaker must be installed. This may be a differential earth-leakage circuit breaker of the current-balance type, arranged to operate when the leakage current to earth reaches not more than 15% of the rated current of the circuit (or 5 amp, whichever is the greater); or may be a voltage-operated earth-leakage circuit-breaker, which may serve the whole or part of the installation. If required, the two methods of protection may be combined.

There are two distinct advantages of earth-leakage circuit-breakers in that they operate on comparatively small earth-leakage currents, and they do not have an appreciable time lag. Both these factors improve the protection afforded against the risk of fire or electric shock.

The differential (current-balance) earth-leakage circuit-breaker depends, as does an earth-leakage indicator or recorder, on the fact that in a sound circuit the algebraic sum of the currents in the current-carrying conductors of any given circuit is zero at all instants. This device can be applied to any single-phase or polyphase circuit, and may be incorporated in a circuit-breaker, or used to operate contacts connected in series with the under-voltage release coil of a breaker or motor starter, etc.

Fig. 1a shows how three current transformers may be used with a trip coil or relay on a three-phase three-wire, or a two-phase three-wire, circuit. The arrows indicate the directions of the currents in a sound circuit at a particular instant, no current passing through the relay coil. Fig. 1b shows the use of a ring type current transformer with the leakage trip coil.

In the circuit shown in Fig. 2a, the current transformers also supply over-current releases O. Should an earth fault occur on phase R, as indicated, the fault current which passes through the R phase conductors will return to the neutral point of the supply through the earth or earthing conductor, instead of through the other two phase conductors. If the earth-fault loop has a high impedance, the increased current through the over-current element in the secondary of the R phase current transformer may be insufficient to trip the breaker, but there will be a resultant current S_E through the leakage-trip coil E to do this. A current transformer must also be provided for the neutral conductor of a three-phase four-wire circuit, as in Fig. 2b, or all four conductors embraced by a ring-type current transformer.

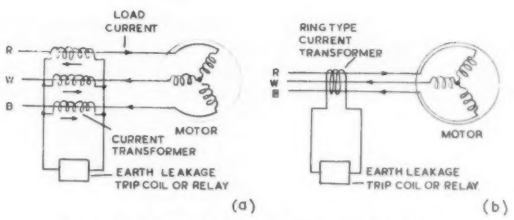


Fig. 1.—Connexions of current-balance earth-leakage trips

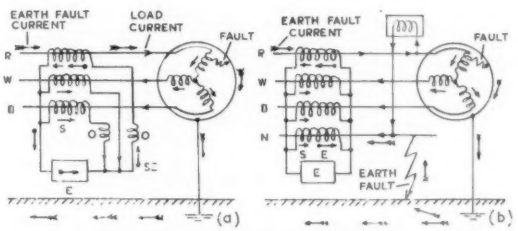


Fig. 2.—Current-balance earth-leakage trips under fault conditions

It should, however, be noted that the earth-fault protection might be rendered ineffective in the event of a second low-resistance earth fault on the neutral of the protected circuit, allowing most of the earth-fault current on an appliance or circuit to return to the earthed neutral point of the supply through the neutral conductor, as in Fig. 2b, which limits the value of the resultant current S_E. Thus periodical tests of the insulation resistance of the whole installation, including the neutral, are advisable.

Single-phase current-balance E.L.C.B.

Fig. 3 shows the connexions of a single-phase breaker having thermal overload elements C and C_1, together with magnetic over-current release coils A and A_1 for protection against short circuits. Should an earth fault occur, the unbalanced currents in the primary windings P and P_1

of the core-balance transformer due to the earth-fault current (indicated by the double arrows) will create alternating magnetic flux in the core. Induced voltage in the secondary winding S will then be applied to the metal rectifier M, causing direct-current to pass through the leakage-trip coil E to trip the breaker. This breaker operates on earth-leakage current as low as 0·5 amp.

Earthing impedance values for current-balance E.L.C.B. protection

Current-balance earth-leakage trips operate practically instantaneously if the leakage current reaches the operating value. Column 2 of Table I gives the maximum permissible leakage currents allowed by the I.E.E. Regulations and the Quarries (Electricity) Order, 1956, for circuits protected by these devices. For circuits operating at 240 volt between phase and neutral, Column 3 gives values of earth-fault loop impedance which will permit such fault currents to flow to trip the breaker in the event of a fault of negligible impedance from a phase conductor to adjacent exposed metal allowing 50% excess current as a safety margin. These are maximum values of earth-fault-loop impedance suggested for 240 volt circuits. For other voltages between phase and neutral the maximum impedance of the earth-fault loop should be proportional to the voltage.

Column 4 of Table I gives suggested maximum values for the impedance between the exposed metalwork and earth, i.e., the consumer's earth-continuity conductor, earthing lead and earth electrode, for use with current

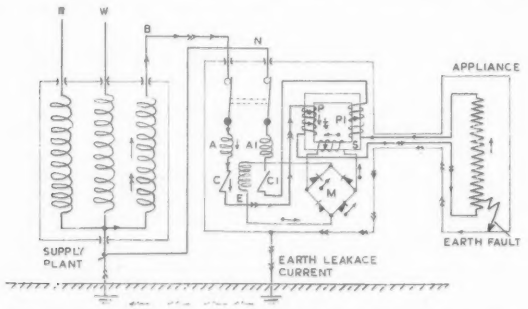


Fig. 3.—Connexions of one type of single-phase circuit-breaker with current-balance earth-leakage protection

Table 1.—SUGGESTED MAXIMUM VALUES FOR EARTHING-CIRCUIT IMPEDANCES WITH CURRENT-BALANCE EARTH-LEAKAGE CIRCUIT-BREAKERS

1 Rating of circuit (amps)	2 Maximum permissible earth-leakage current (amps)	3 Suggested max. permissible impedance (ohms) of earth-fault loop on a 240 volt circuit	4 Suggested max. permissible impedance (ohms) of connexion between exposed metalwork and the general mass of earth
5	5	32	8
10	5	32	8
15	5	32	8
20	5	32	8
30	5	32	8
40	6	26·7	6·6
60	9	17·8	4·4
80	12	13·3	3·3
100	15	10·7	2·6
125	18·7	8·6	2·1
150	22·5	7·1	1·78
175	26·2	6·1	1·53
200	30	5·3	1·3
300	45	3·5	0·89
400	60	2·7	0·66
500	75	2·1	0·53
	Trip operating at 0·5A.	320	80

balance e.l.c.b.s. The values in Column 4 are irrespective of the phase-to-neutral voltage of the supply. With these values earth-fault current should be cut off immediately if it causes the exposed metalwork to reach 40 volt to earth. With the sensitive trip, operating on 0·5 amp leakage current, good protection is afforded on circuits having quite high earthing impedances, as indicated by the bottom entries in Table I. However, it should be noted that the I.E.E. Regulations state a maximum impedance of 1 ohm for the earth-continuity conductor from the consumer's earthing terminal to exposed metalwork on any final sub-circuit.

The possible voltage between the neutral point and earth is equal to the product of the resistance of the neutral-point earthing electrode and the fault current; this voltage is limited by the comparatively low operating current of the current-balance trips. This system can be used with an ordinary earthing system or a system in which the exposed metalwork is connected to the earthed neutral point by a separate conductor, or a P.M.E. system. It provides good protection against fire risk, due to the low tripping current, and good protection against shock, with reasonably good earthing.

Discrimination by current-balance earth-leakage circuit-breakers

The discrimination provided by these devices is not as good as that of fuses or overload circuit breakers. A main breaker controlled by current-balance trips might feed sub-circuit breakers of lower current-rating and having the same type of trips. However, in spite of the different current settings of the breakers in series, an earth fault on a sub-circuit might cause the main breaker to trip. Obviously if the earth-fault loop impedance to the sub-circuit breakers is low enough to allow earth-fault current to trip the main breaker, the earth-fault loop impedance to the ends of the sub-circuits will probably also be low enough to allow earth-fault current to trip the main breaker, unless the impedance of the earth-continuity conductor from the sub-circuit breakers to the ends of the sub-circuits is rather high. The latter impedance must be limited to comply with I.E.E. and other regulations, and to limit the volt drop on this conductor under earth-fault conditions.

The current-balance earth-leakage circuit-breaker may be used for individual protection of main distributing feeders fed from a central point, but the breaker controlling a feeder is likely to be tripped before an earth fault on a sub-circuit causes melting of the sub-circuit fuse. It is unfortunate that lack of discrimination may limit their use on installations where breakers of different current rating are connected in series. The normal operating time of such an e.l.c.b. may be about 0·02 sec. Whilst rapid operation is a desirable feature, it would appear that the incorporation of an inverse time/current time lag, up to a maximum of about 0·1 sec or so, might permit the advantages of these protective devices to be obtained on high-current circuits where discrimination is required.

Voltage-operated earth-leakage circuit-breakers

With this system of protection the exposed metalwork is connected to earth through a leakage trip coil which is intended to switch off the supply if an earth fault causes the metalwork to reach a dangerous voltage to earth, up to about 40 volt. The I.E.E. Regulations may be complied with by the use of such a device without, or with, direct

earthing of the metalwork, although direct earthing is still required for certain portable apparatus coming under the Electricity Regulations of the Factories Acts, and by some other regulations.

Fig. 4 shows the connexions of a voltage-operated e.l.c.b. having magnetic over-current trip coils A, A_1 and A_2, together with thermal overload releases C, C_1 and C_2. The device is shown solo-connected, i.e., on a circuit where the exposed metalwork is connected to earth only through the leakage trip coil T. In the event of the insulation between any conductor and its associated metalwork becoming faulty, so that a fraction of an amp earth-leakage current reaches the metalwork and passes to the earthed neutral point of the supply through the trip coil T and its earth electrode F, the breaker will be opened within 0·1 sec.

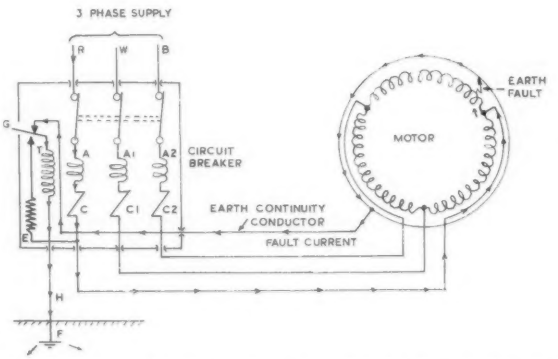


Fig. 4.—Connexions of one type of voltage operated earth leakage circuit-breaker solo connected on a 3-phase motor circuit

Operating values of voltage-operated earth-leakage circuit-breakers

B.S.S. 842 requires that, on a 50 cycle supply, the voltage-operated e.l.c.b. must not trip on leakage currents below 15 milliamp, but must trip with not more than 40 volt across the trip coil and its earth electrode, when the latter has a resistance of up to 500 ohm; or with not more than 24 volt across the trip coil and its earth electrode when the latter has a resistance of 200 ohm. In practice the tripping current of these devices depends on their design, and may be up to about 65 milliamp (mA).

It will be appreciated that the device only operates in the event of voltage existing on the exposed metalwork to which the trip coil is connected. Thus it is most important that all the exposed metalwork associated with the conductors on the protected circuit should be bonded together and connected to the trip, otherwise an earth fault on an isolated section of the metalwork might leave that section alive at a dangerous voltage to earth.

Where the metalwork is connected to earth only through the trip coil the circuit will be interrupted as soon as earth-leakage current, equal to the operating value of the device, occurs. Provided the resistance of the trip-coil earth electrode is not more than 500 ohm, the breaker will trip if the metalwork reaches not more than 40 volt to earth, but if the resistance of this earth electrode exceeds 500 ohm the breaker may not be tripped until the metalwork reaches a higher voltage to earth. This is indicated in Fig. 5, which refers to three designs which comply with B.S.S. 842. The characteristic A refers to a particular trip operating on 60 mA.

Protection of main circuit-breaking device

As in the case of fuses, overload circuit-breakers, and current-balance e.l.c.b., the voltage-operated e.l.c.b. provides no protection against the effects of an earth fault on the supply side of the contacts of the circuit-breaking device which it controls. For this reason a voltage operated e.l.c.b. is usually fitted in an insulated case.

Protection against an earth fault on the supply side of the contacts of a main ironclad circuit-breaker must depend on some other protective device on the supply side. Protection against overheating of circuit conductors or earthing conductors due to such an earth fault can be provided by proper setting of the protective device on the supply side, with adequate direct earthing of the case of the breaker. If the earth-fault loop impedance to the main breaker cannot be made sufficiently low to ensure that the protective device on the supply side will operate with sufficient rapidity to ensure protection against shock risk, resort may be necessary to isolation of the metalwork of the breaker from other metal and screening so that the casing cannot be touched whilst the supply is applied to the breaker.

Isolation for discrimination

In most medium-sized and large installations it is desirable that, should an earth fault occur, only the faulty section will be switched off. With voltage-operated e.l.c.b. protection such discrimination requires that each section be controlled by a separate e.l.c.b., or by a voltage-operated earth-leakage trip coil which controls contacts in series with an under-voltage release coil in a breaker feeding each section. It is also necessary that there should be no connexion or contact between the

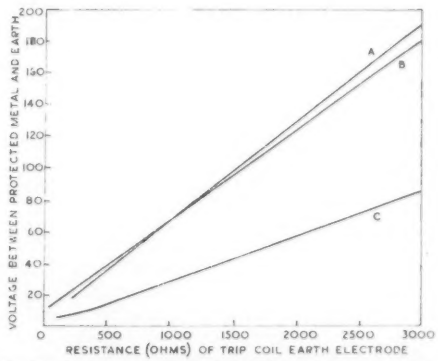


Fig. 5.—Operating voltages of three different designs of voltage-operated E.L.C.B's with different earth electrodes

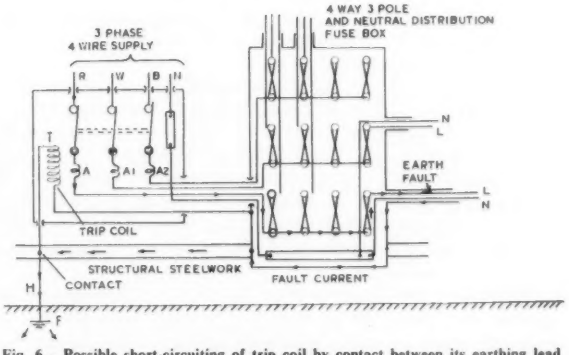


Fig. 6.—Possible short-circuiting of trip coil by contact between its earthing lead and structural steelwork

exposed metalwork on the various sections which are controlled by the separate breakers. Such separation is difficult to obtain in many industrial installations, although it might be assisted by using T.R.S.-sheathed or P.V.C.-sheathed cables, plastic conduit, or plastic-sheathed metal conduit, in conjunction with an insulated earth-continuity conductor between the trip coil and the various metal casings needing protection.

Connecting and testing the tripping device

In all cases it is most important that the trip coil should not become short circuited by any direct or indirect contact between its earthing lead and the protected metalwork. Fig. 6 shows how a bare earthing lead H might short circuit the trip coil T by contact with structural steelwork. The lead H between the trip coil T and its earth electrode F must, therefore, be insulated. Where isolated sections of an installation are controlled by separate voltage-operated e.l.c.b.s it is permissible to connect the earth-leakage trip coils on the various breakers to the same earth electrode, provided this has a fairly low resistance and the exposed metalwork is connected to earth only through the leakage-trip coils.

The operation of the breaker itself, the earthing lead H, and its earth electrode F, can be tested by pressing the test key, which is shown at G in Fig. 4. This connects the trip coil T between one phase and earth through the resistor E. As will be seen later this does not give a complete test of the protective system, however.

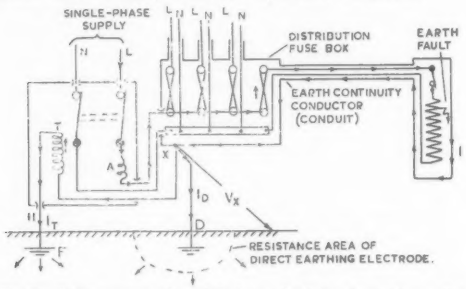


Fig. 7.—Voltage-operated earth-leakage circuit-breaker with parallel direct earthing

Parallel direct earthing

As previously mentioned it is permissible, and in some cases compulsory, to connect the exposed metalwork directly to earth, even when it is also connected to earth through the trip coil of a voltage-operated e.l.c.b. In fact such direct earthing connexions may exist unsuspected on many installations due to fortuitous contact between the exposed metalwork associated with the conductors and other metalwork in contact with earth, although the impedance of a fortuitous earthing connexion may be appreciable in many cases.

Whilst such a parallel direct earthing connexion provides a second line of defence, in that it may enable fuses or an overload circuit-breaker to operate in case of earth fault, it does make the voltage-operated e.l.c.b. less sensitive. Considering first the case illustrated in Fig. 7, where the trip coil T is connected to the same point X on the exposed metalwork as is a direct-earthing electrode D, the trip-coil earth-electrode F lying outside the resistance area of D.

The trip coil T will operate as soon as an earth fault causes the point X to reach a certain voltage to the general mass of earth at which the trip is designed to operate. However, most of the earth-fault current I will pass directly to earth, the current I_T through the trip coil being much less than I_D. Neglecting the small current I_T through the trip coil, it will be seen that the trip will now permit an earth-leakage current up to a value equal to:

$$\frac{\text{Operating voltage of the trip coil T}}{\text{Impedance of direct earth connexion D.}}$$

With an operating value of 40 volt, and a 1 ohm direct-earthing impedance, the trip will not operate on leakage currents of less than 40 amp. On a low-current circuit it is, of course, possible that excess-current protective devices might operate before the e.l.c.b. in such a case. However, with parallel direct earthing, it is advisable to use a trip coil of low operating voltage, as indicated by the characteristic C in Fig. 5, and to have a low earth electrode resistance for the trip coil.

If the neutral-point earthing electrode has a comparatively high resistance this may limit the value of the earth-fault current below the operating requirements of the voltage-operated e.l.c. or excess-current devices, where parallel direct earthing exists, and may thus limit the voltage V_X between the point X and the general mass of earth. V_X is equal to $I_D \times Z_D$, where Z_D is the impedance of the direct-earthing connexion between the point X and the general mass of earth. The e.l.c.b. will still cut off the current if the point X reaches a voltage equal to the operating voltage of the coil; if the earth-fault current reaches the value Tripping voltage/Z_D. However, lower values of earth-fault current might permit the neutral point of the system to remain at an appreciable voltage to earth, up to the value (Operating value of leakage trip $\times$ Resistance (ohm) of the neutral-point earthing electrode) $\div$(Impedance (Z_D) ohm of consumer's parallel direct-earthing connexion).

Separation of parallel earth electrodes is necessary

If the earth electrode F for the trip coil T should lie inside the resistance area of any direct-earthing electrode D on the controlled circuit, as in Fig. 8, the protection

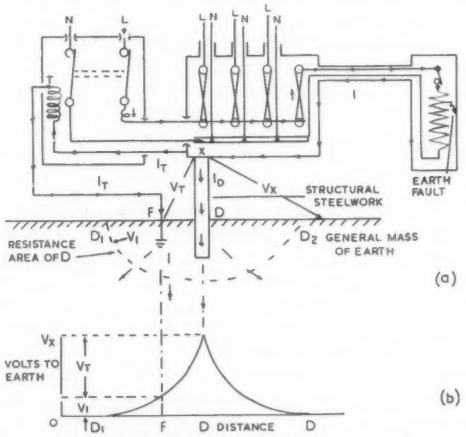


Fig. 8.—Effect of trip coil earth electrode lying in resistance area of a parallel direct earthing electrode

will be less effective. Under earth-fault conditions the voltage V_X between the point X and the general mass of earth will then be greater than the voltage V_T applied to the trip coil. In that case the current will not be cut off until the point X has reached a higher voltage to the general mass of earth than the operating voltage of the trip coil T. Thus it is necessary, with fortuitous or intentional parallel direct earthing, that the earth

electrode for the trip coil be placed outside the resistance area of the direct-earthing connexion.

If the earth electrode for the trip coil controlling one section A of an installation should lie within the resistance area of a direct earthing connexion on another section B there might be a possibility of the section A being tripped out due to an earth fault on section B, whilst voltage might remain between the metalwork of section A and earth. For these reasons, good discrimination is often difficult to obtain with voltage-operated earth-leakage breakers in industrial installations.

Tripping due to stray earth currents

Fig. 9 shows a layout which was responsible for frequent tripping of a voltage-operated e.l.c.b. controlling plant U, at one consumer due to an earth fault on the installation Y of another consumer. This effect could occur even if the two consumers were connected to different supply systems. The trip-coil earth electrode F and the direct earth connexion D, provided by the outlet piping of a direct-coupled pump, lay at different points within the resistance area of the neutral-point earthing electrode P of the supply transformer. When an earth fault occurred at Y the fault current created a volt drop V_P between the neutral point P and the general mass of earth, due to a high resistance at P. The respective voltages between the mass of earth were V_F from F, and V_D from D. The voltage difference V_T thus applied to the sensitive trip coil T caused the motor to be switched out.

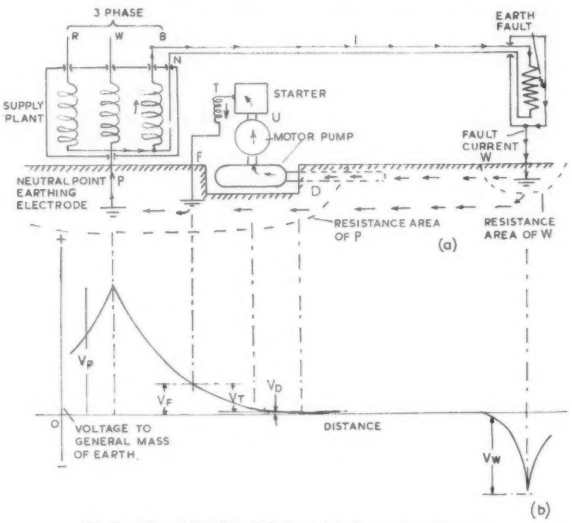


Fig. 9.—Operation of earth-leakage trip due to stray currents

Limitation of voltage to earth

Fig. 10 shows a hot-water system in which the casing of the immersion heater has parallel direct earthing through the water piping. The trip coil is correctly connected to the heater casing and to an electrode F outside the resistance area of D. The trip will thus operate as soon as an earth fault causes the voltage between the heater casing and the general mass of earth to reach the operating value of T. If the earthing lead for the trip coil T was connected to the water pipe at the point D where it emerges from the ground the trip would only function when the voltage between this point and the general mass of earth reached the operating value of the trip coil. The heater casing would then be at a higher voltage to earth due to the volt drop on the piping from D to the heater.

Parallel earthing on multiple circuits

With the parallel earthing connexions shown in Fig. 11 the trip coil T will operate when the voltage between the casing of G and earth reaches the operating value of the coil. However, if an earth fault occurs on the motor N the voltage V_N between the motor casing and earth may exceed this value due to the volt drop on the earth continuity conductor from N to G. If the trip coil T was connected between F and N it would operate as soon as the motor casing at N reached the operating value of the trip coil, to earth, in the event of an earth fault on the motor. When thus connected it would also function if any of the metalwork reached the operating voltage of T, to earth due to an earth fault at G, since the volt drop from G to N due to the small trip-coil current would be negligible with reasonably low continuity impedance.

However, with T connected between F and N, an earth fault on the motor K might allow the casing at K to reach a higher voltage to earth than the operating value of T, due to the volt drop caused by the earth-fault current passing along the earth-continuity conductor from K to G. Thus, when a voltage-operated e.l.c.b. controls more than one parallel circuit, with direct earthing, the best point of connexion for the trip coil, as well as the simplest, is usally at the earthed point.

As with other protective systems it is important that all the exposed metalwork on a section requiring protection by a voltage-operated e.l.c.b. should be efficiently bonded together. Where parallel direct earthing exists the point of connexion of the leakage trip coil is important, the impedance of the earth-continuity conductors should be maintained at a low value to limit the volt drop on these conductors when earth-fault current flows, a

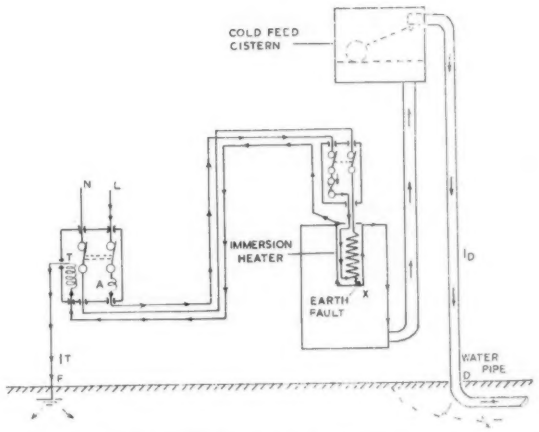


Fig. 10.—Parallel earth-leakage protection for an immersion heater

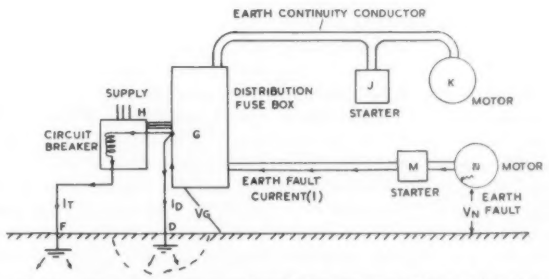


Fig. 11.—Effect of volt drop on earth continuity conductor with parallel earthing and voltage-operated earth-leakage circuit-breaker

sensitive tripping device should be used, with a fairly low resistance for the trip-coil earth electrode.

If a voltage-operated e.l.c.b. which trips at 20 volt is connected from a separate earth electrode to the same point on exposed metalwork as is a direct-earthing connexion of impedance Z_D ohm, the trip will operate when earth-leakage current equal to $20/Z_D$ amp passes through the direct-earthing electrode. If the impedance of the earth-continuity conductors from the direct earthing point to any exposed metalwork on the installation is limited to 1 ohm, the trip will operate when earth-leakage current causes a maximum volt drop of $20/Z_D$ volt on this conductor. Thus the trip will operate if any earth fault causes the voltage between any of the exposed metalwork and earth to reach a maximum value of $20+(20/Z_D)$ volt. Thus, if the impedance Z_D of the direct-earthing connexion exceeds 1 ohm, good protection against shock risk will be obtained. Under these conditions the trip would operate if an earth fault on the protected circuit caused the neutral point to reach a voltage to earth equal to $20\times(Z_P/Z_D)$, where Z_P is the resistance (ohm) of the neutral-point earthing electrode.

Combined current-balance and voltage-operated earth-leakage circuit-breaker

There is some justification for the view that, whilst a current-balance e.l.c.b. is primarily a protective device against fire risk, a voltage-operated e.l.c.b. is primarily a device for protection against electric shock risk, although the extent to which the two functions overlap largely depends on the impedance of direct-earthing connexions and earth-continuity conductors.

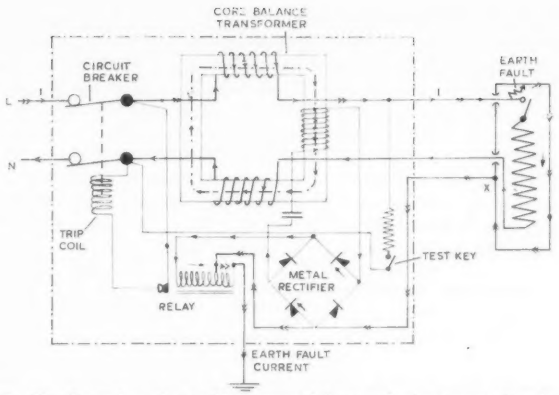


Fig. 12.—Connexions of a combined current balance and voltage-operated earth-leakage circuit-breaker

Fig. 12 shows the connexions of a combined current-balance and voltage-operated earth-leakage circuit-breaker, rated at 60 amp, in which the two principles of protection are combined. In the event of an earth-fault the breaker will be tripped if the earth-fault current reaches 0·2 amp, or if the voltage of the exposed metalwork at the point of connexion X reaches 40 volt to earth. The voltage-operated feature gives good protection against shock from metalwork not otherwise earthed, or with high-resistance direct-earthing. The current-balance feature provides excellent protection against fire risk, and tends to limit the shock risk due to high-impedance earth-continuity conductors.

Silicon Nitride as a High Temperature Material

Silicon nitride is a ceramic material with promising physical properties for engineering purposes. It is resistant to thermal shock and oxidation and has adequate creep strength at 1200°C.

A NEW material having excellent thermal shock and oxidation resistance and adequate creep strength at 1200° C has been produced by the Metallurgy Division of the Admiralty Materials Laboratory as a result of a search for stator blade materials for use in gas turbines at 1200° C. The best material was found to be silicon nitride stiffened with a fine dispersion of silicon carbide. The methods of producing components in the best physical form for the projected application are described in the Bulletin (No. 15) of the National Research Development Corporation. Silicon nitride has been known since 1857 but it is only in recent years that its structure has been determined with any degree of certainty.

Silicon nitride of formula Si_3N_4 exists in two distinct phases both of hexagonal structure but differing slightly in lattice dimensions. The alpha phase is formed at temperatures below 1400° C and the beta phase above 1450° C. At intermediate temperatures a duplex structure results. It has high dimensional stability and oxidation resistance at temperatures up to 1400° C. When the material is tested in air at 1200° C it shows an initial slight weight gain (which may be due to unreacted silicon) and is then stable for periods of 100 hours or more. Silicon nitride is not wetted by any of the common metals nor is it attacked at room temperature by gases containing sulphur or chlorine and it is resistant to most liquid acids. It is attacked by hydrofluoric acid although it is more resistant than silica. It is attacked by potassium hydroxide at about 400° C and by sodium sulphate and vanadium pentoxide at 1000° C.

The bulk density of fully reaction-sintered nitride varies between 2·2 and 2·6 so that the final product contains between 20 and 33% voids. The coefficient of linear expansion is $2{\cdot}5\times10^{-6}$ per °C over the range 20 to 1000° C. Thermal conductivity at a specific gravity of 2·2 is given as 0·0037 C.G.S. units. Electrical resistivity when dry is about $1{\cdot}4\times10^{7}$ ohm-cm and the dielectric constant is 5·3 at 5 megacycles, when the loss tangent is 0·067.

An average value of Young's Modulus for material with a density of 2·2 g/cc is 4000 ton/in.^{2} at room temperature, and about the same value at 1000° C.

Readings with the Reichert micro-hardness tester show that the indentation hardness is about 1000 to 1100 VPN, varying with density.

The modulus of rupture was determined by three-point loading of beam specimens at room temperature and 1200° C. The best result was obtained with hydrostatically pressed powder which after nitriding had a density of 2·5 with a strength of 10 ton/in.^{2} at room temperature rising to 13 ton/in.^{2} at 1200° C.

Thermal shock resistance

As a result of its low coefficient of thermal expansion and Young's Modulus the thermal shock resistance of silicon nitride was expected to be high by comparison with other ceramic materials. Results of tests indicate

that it is possible to subject wedge-shaped discs to as many as 50 cycles of rapid heating to 1000° C and cooling before radial cracks begin to appear at the edges. These results indicate that silicon nitride is outstanding among refractory materials in its resistance to thermal shock and under some conditions approaches the performance to be expected from metals.

The creep strength of pure silicon nitride of density 2·1 is disappointingly low. Tests with a 5% addition of silicon carbide of maximum particle size 36 microns produced best results. It was also found that the creep strength was significantly increased by an increase in density, the best results being obtained with isostatically pressed powder of density 2·5.

Whilst silicon nitride is attacked by few molten metals it is rapidly attacked at high temperatures by some molten salts, of which sodium sulphate and vanadium pentoxide are of importance. The porous nature of ordinary silicon nitride results in rapid disintegration of the component at temperatures of 1000° C and over, but it was found possible to glaze a porous silicon nitride component with a silica-alumina glaze so that it was not attacked by the molten compounds after 24 hr at 900° C. This glaze is also completely watertight and can be used with advantage when it is desired to prevent the reduction of electrical properties by adsorbed moisture.

Field trials

The material has been tested in a number of gas turbines, combustion chamber test rigs and rockets.

Stator blades

Silicon nitride was originally intended for use as a stator blade material in a high temperature gas turbine which employed a water-cooled rotor. After 250 hr of intermittent service, the blade was in perfect condition and covered with a light layer of combustion products.

It has been found practicable to use silicon nitride as a bearing material for the Nimonic alloys at gas turbine operating temperatures.

Its good thermal shock resistance and high electrical resistivity make silicon nitride a potentially valuable material for electrical insulators which are subject to violent temperature changes such as are encountered on rocket launching platforms.

The high thermal shock resistance and chemical inertness suggest that silicon nitride may also be of use as a support for high temperature catalysts, as thermocouple sheaths, crucibles, supports for advanced heat treatment, and containers for special purification and diffusion operations such as are employed in the semiconductor field. Other applications, some of which are in current use, are as furnace chamber linings, shackles and components for high temperature testing, supports in high temperature/high pressure water systems, and brazing jigs. Apart from its obvious use as an engineering material, silicon nitride has applications as a dielectric.

Design considerations

Design philosophy should not follow the conventional practice for metals but should take into account the low coefficient of expansion and room temperature brittleness of this new engineering material. In particular, local stress concentrations which arise from abrupt changes in the section or from local pressure exerted as a result of differential expansion of the remainder of the system should be avoided. These considerations are particularly important if glazed material is being used.

Production of silicon nitride components

Silicon nitride is normally made by heating elemental silicon in an atmosphere containing nitrogen. When powder of 200 mesh or finer is used the reaction goes to completion and produces a light grey powder which closely corresponds to the formula Si_3N_4. By using silicon powder pressed at 2 ton/in.^{2} or more, so that the angular particles are in multiple point contact, it is possible to induce silicon nitride crystals to connect the original particles and in this way to build up a coherent structure. The resulting material is mechanically strong, although brittle at room temperature, but it is microporous and contains at least 20% voids. The reaction takes place slowly at temperatures below 1400° C but it is necessary to give a preliminary reaction sintering in the temperature range 1200 to 1400° C so that a cellular structure of silicon nitride can be formed which confines the elemental silicon and confers high temperature rigidity. The second stage of the reaction is much more rapid and takes place at 1400–1500° C when the silicon contained in the previously made lattice is molten. The low temperature reaction product is relatively soft and composed of a matte of fine needle-shaped crystals, whereas the product produced at high temperatures is of much greater hardness and density. The characteristics of the final product can be considerably modified by variations to the reaction sintering programme and in particular to the ratio of the times spent above and below the melting point of silicon (1420° C).

For the production of shapes two types of equipment are in common use:

(*a*) *Closed dies.*—In the design of the die sets it is essential to allow for the fact that silicon powder is extremely hard and angular and does not flow readily under high pressure as do metal powders. Failure to do this invariably results in pressing cracks and in a bad case will result in the compact emerging from the die as a series of thin washers. Water may be used with advantage as a die lubricant and it also confers some additional "green" strength but organic compounds such as cetyl alcohol should be avoided as they give rise to small but uncontrollable amounts of carbon in the final product, and this has been found to have a detrimental effect on the creep properties. The optimum quantity of water for 200 mesh powder was found to be 25% by weight.

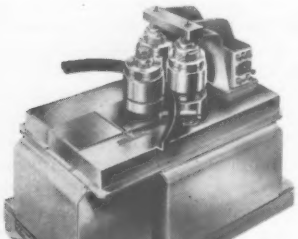
(*b*) *Hydrostatic pressing.*— Simple shapes can be produced free from pressing cracks by the isostatic method. First a rubber sac about 10% larger than the desired shape is made. Then dry silicon powder is loaded into the sac which may conveniently be surrounded by a perforated metal container to help to retain its shape; the whole assembly is meanwhile vibrated to promote even distribution of powder. The sac is sealed by any convenient means and placed in a hydraulic cylinder and subjected to a pressure of about 16 ton/in.^{2}. The pressure is released and the body, which is now sufficiently strong to be handled with care, is removed from the rubber sac. It is then nitrided.

Fully sintered silicon nitride can only be machined by diamond impregnated tools or ultrasonic methods, but if the sintering is suitably controlled the product has the consistency of talc and is sufficiently strong to be held in a conventional machine tool yet weak enough to be machined by ordinary methods without undue wear of the cutting tool. The component is then fully nitrided in the usual way. Shrinkage on final nitriding amounts to only about 0·01% and components can, therefore, be made to close tolerances with comparative ease.

Section Rolling Machine

An entirely new BESCO horizontal all-steel section rolling machine is designed specifically for the rapid forming of rings, with a power-operated adjustable roller. The main frame is fabricated from heavy steel sections, and is of extremely robust construction. It will be one of the main exhibits by F. J. Edwards Limited, 359–361 Euston Road, London NW1, at the International Machine Tool Exhibition.

Removable panels enclose the drive units and the twin main driving rollers are contained in a robust steel housing and supported by an overhead bracket to prevent deflexion.



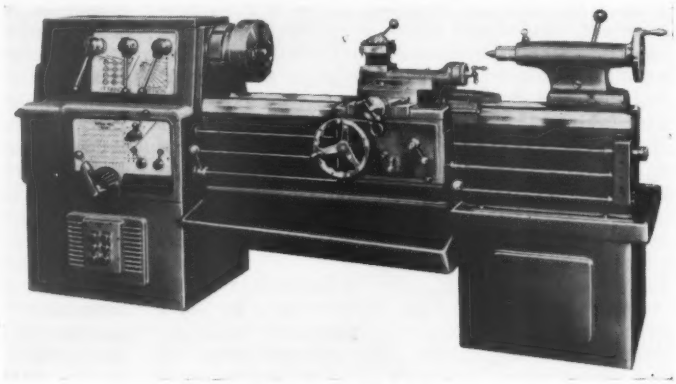
Besco horizontal rolling machine

The third adjustable pressure roller is mounted on a heavy steel slide in taper roller bearings to allow free rotation under the heaviest loads. A pair of adjustable hardened guide rollers are provided for supporting the work while rolling. The main rollers are made from a spherical graphite iron, surface hardened to resist wear under the heaviest duty.

The drive to the main driving rollers is from a high torque 5 hp reversing motor through spur gearing to enclosed worm gearbox; whilst the adjustment to the pressure rollers is through a separate 2 hp reversing motor and worm drive to powerful square thread lead screw, which enables the operator to make initial bends in heaviest sections before rolling. For repetition rolling, an adjustable limit switch and gauge is provided on the adjustable roller slide.

Both motors are fitted with magnetic brakes to ensure positive control. A central panel contains forward reverse and stop push buttons for the pressure roller motor and start stop buttons, together with an indicator light, for the main driving motor. A joystick controller provides for the reversing of the drive rollers. A main isolating switch is incorporated on the machine. The electrical equipment is suitable for 400/440 volts, 3-phase, 50 cycles supply.

The standard 10 in. dia rollers are adjustable to accommodate all standard rolled steel sections, within the specified range. The machine will handle angles and tees: leg out up to $2\frac{1}{2}$ in. $\times$ $2\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in., smallest diameter 24 in.; leg in up to 2 in. $\times$ 2 in. $\times$ $\frac{1}{4}$ in., smallest diameter 18 in.; channels flange out up to 4 in. $\times$ 2 in.; flange in up to 4 in. $\times$ $1\frac{1}{2}$ in.; flats on edge up to $2\frac{1}{2}$ in. $\times$ $\frac{1}{2}$ in.; rounds up to $1\frac{1}{2}$ in. dia; squares up to $1\frac{3}{8}$ in.



Harrison 17 in. swing lathe

17 in. Swing Lathe

A new Harrison 17 in. swing lathe has a wide bed cast with rear facing apertures to allow for easy disposal of cuttings and swarf. Twelve spindle speeds within the range 32–1500 rpm are available from a single-speed 10 hp motor and the all-geared headstock has a three bearing mounted large diameter spindle with an L2 taper nose and is bored to pass a 3 in. dia bar. A Matrix reversing clutch is fitted and the totally enclosed gearbox gives threads up to 120 per inch. Hydraulic built-in copying equipment can be fitted and a complete range of attachments is available for taper turning and milling. Bed lengths are available admitting up to 79 in. between centres. A 40 in. machine will be shown by the makers, T. S. Harrison & Sons Limited, of Union Street, Heckmondwike, Yorkshire, at the International Machine Tool Exhibition.

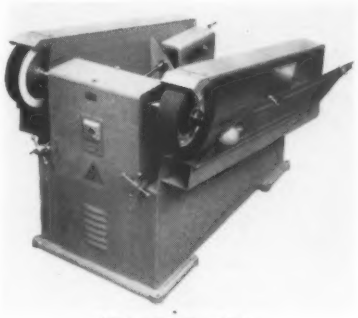
Two New Grinders

Among a full range of grinding polishing machines to be shown by The R.J.H. Tool and Equipment Company Limited, of Artillery Street, Heckmondwike, Yorkshire, on Stand 325 in the Grand Hall Gallery at the International Machine Tool Exhibition, will be two new machines, the "Trim Tool" grinder and the "Jumbo" self-contained backstand machine.

The Trim Tool grinder is mounted on a pedestal and complete with its own coolant system, with either diamond lap or green grit wheel suitable for carbide tipped tool finishing.

The Jumbo will accommodate two

The Jumbo self-contained backstand machine, one of the two new grinders being shown by The R.J.H. Tool and Equipment Company Limited

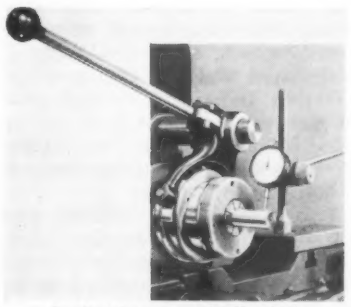


"Trim Tool" grinder

136 in. × 4 in. belts, and is powered by a 4 hp motor running at 1500 rpm or 6 hp at 3000 rpm with V-rope drive to main spindle. A range of speeds is available to suit different types of work. The main feature of this new design is the guarding which is an integral part of the machine body, as also the dust exhaust trunking. Easy and quick belt tension and tracking facilities are provided.

Collet Chuck

Since the last International Machine Tool Exhibition, Crawford Collets Limited, of Witney, who have been specializing for over 60 years in the manufacture of collets, have produced several new lines and



Crawford lever-operated collet chuck

installed even better production methods. They will be showing, on Stand No. 313, for the first time at this year's Exhibition an entirely new lever-operated collet chuck which not only takes their now well-known Multibore collet with its $\frac{1}{8}$ in. bore size range but has a more powerful and improved operating gear.

Recently Crawford Collets have equipped a special research department to study the operation, tension and life of feed fingers used on present day high-speed automatics. They have also put in special plant for quantity production of tungsten carbide bushes.

Lubricants for Machine Tools

Many of the developments in machine tool design and operation require new or improved formulations for cutting fluids, and the display by Fletcher Miller Limited, of Hyde, Cheshire, on Stand 618 on the 2nd floor of the Empire Hall at the International Machine Tool Exhibition will contain many such specially evolved industrial lubricants.

Cutting fluids to be featured will cover the tooling needs of most metals and all cutting processes. Of the newer introductions, there will be the non-fatted soluble oils with their greater stability and tolerance to hard water conditions (Almaredge is typical) and the non-staining sulphurized oils, as represented by the Swift S.S. series. The special interest here is that because there is no free sulphur present, these oils are dual-purpose for cutting both steels and copper-rich metals.

Performance demands on some cutting media are critical in that the oil chosen must give an exacting finish on such obdurate materials as high nickel, heat-resistant alloys. The product Swift R.11 is an example, now widely accepted for tooling aircraft jet engine components from these special alloys.

On the lubrication side, full coverage will be given to the multifarious needs of current machine tool designs. In addition to the well-known Gena range for general purpose duties and the inhibitor-treated Veta grades for both meticulous lubrication and hydraulics, special mention is made of Almplas, a lithium-based grease which not only is water-resistant and all-purpose in its applications, but has marked stability over a wide range of operating temperatures.

Almost one-third of all the oil-using exhibitors will be using Fletcher Miller coolants or lubricants, conveniently dispensed from self-propelled trucks and equipment, much of which has been specially designed for this large-scale operation.

Beaver Milling Machines

Ten machines and attachments for milling are being shown at the International Machine Tool Exhibition by Balding Engineering Limited, Beaver Works, Bessemer Road, Norwich. They include both horizontal and vertical types, turret machines, a rapid traverse and a rotary table.

The Beaver AH horizontal milling machine appears in standard form and also set up as a universal miller with a special head. The head is mounted on the overarm of the machine and is driven from the spindle by a toothed belt, thereby achieving both horizontal adjustment and a maximum spindle nose to table dimension. There are 18 spindle speeds from 100 to 3400 rpm, the spindle has a No. 30 IST taper with drawbolt, the maximum dimension from spindle nose to table is $16\frac{1}{2}$ in., the transverse adjustment is from 4 in. max to 12 in. min from the column warp, and the head swivels 360° in both planes.

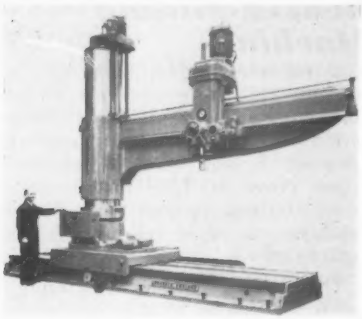
The Beaver A vertical miller is shown in the standard form and also fitted with a hydraulic copying attachment by Hepworth Iron Company Limited, giving hydraulic feeds to knee and table in the vertical direction. The copying attachment is mounted on a slide fitted to the head of the machine.

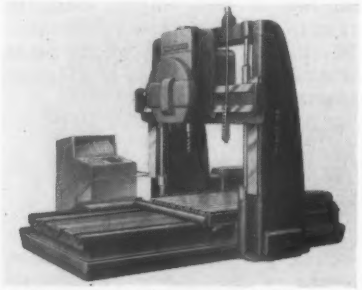
The Beaver VBRP swivelling turret milling machine is shown in standard form and also arranged as a jig borer, for which purpose it is fitted with optical measuring equipment. The VBA vertical miller is shown in its standard form.

The company's rapid traverse attachment is exhibited. Fitted to a machine it provides a rapid power traverse to the table.

A rotary table, originally designed for use with Beaver machines but suitable and available for general use, is also exhibited. It is hand operated and is of 8 in. dia with a 1 in. central hole. Four $\frac{3}{8}$ in. radial standard T-slots are provided. Overall height is $2\frac{7}{8}$ in. The table is graduated through 360° and the dial in 02′ divisions.

A further item is a Beaver VBRP machine fitted with the hydraulic copying attachment but otherwise in standard form.





Archdale vertical spindle co-ordinate drilling machine. Left, 14 ft Archdale radial drilling machine with hydraulic pre-select saddle and traverse base

Archdale twist drill grinding machine

Archdale Drilling and Milling Machines

Eighteen machines will be shown by James Archdale & Co. Limited, of Blackpole Works, Worcester, at the International Machine Tool Exhibition. Eleven are drilling machines, or machines connected with drilling, and seven are milling machines. Twelve of the machines are new introductions.

A 38-in. automatic feed sensitive radial machine drills up to 1 in. in mild steel and 1¼ in. in cast iron. It has nine speeds ranging from 129 to 1627 rpm or 65 to 815 rpm; with a two-speed motor the range is extended to 64–1627 rpm. Three feeds are provided of 0·005 in., 0·011 in., and 0·02 in. per rev.

A 3 ft 6 in. light type sensitive centralized control radial arm machine has a single pillar frame with power lock to saddle and arm and drills up to 2 in. and taps up to 1 in. U.N.C. The machine is provided with 15 spindle speeds, 4 to 2000 rpm, or twelve spindle speeds, 80 to 4000 rpm. It has face feeds, from 0·005 to 0·30 in. per rev.

A 6 ft medium duty mechanical pre-select radial machine has power locks to saddle and arm, a 19-in. column and drills up to 3 in. in mild steel and taps up to 2 in. U.N.C. There are 16 spindle speeds, 10 to 1000 rpm, 15 to 1500 rpm or 22 to 2200 rpm, all pre-selected. Feeds are 0·002 in. to 0·05 in. per rev, or 0·004 to 0·029 in. per rev, in addition to five tap leads.

Among the new machines are five for drilling. One is a 9 ft medium duty pre-select radial machine with 23 in. dia single pillar frame. This machine has power swing and power lock to saddle and arm and drills up to 3 in. in mild steel and taps up to 2 in. U.N.C. Sixteen spindle speeds are provided, 10 to 1000 rpm; or 15 speeds, 15 to 1500 rpm; or 22 to 22,000 rpm, all pre-selected. Feeds are 0·002 to 0·050 in. per rev or 0·004 to 0·029 in. per rev, and there are five tap leads.

Another new drilling machine is a 14 ft radial with hydraulic pre-select saddle and traverse base. Power swing to arm and power locks to saddle and arm are provided and there is power traverse to the saddle along the arm. The machine drills up to 4 in. in mild steel and taps up to 3 in. U.N.C. There are 24 spindle speeds, 7 to 1450 rpm, and 18 feeds, 0·002 to 0·04 in. per rev. Pre-selection is provided for both speeds and feeds.

A new vertical spindle co-ordinate drilling machine has a drilling area 6 ft square and drilling capacity 1¾ in. dia and tapping capacity 1¼ in. dia in steel. It is arranged for automatic drilling, tapping, reaming and spot facing and has 15 spindle speeds, 40 to 1500 rpm, 30 feeds, ½ in. to 24 in. per min. Tape control gives automatic positioning, speed and feed changing, automatic tool changing and automatic spindle cycle. The quill feed is hydraulic. The machine frame is of portal design with fixed cross rail or rail with power elevation. Manual control by push buttons is provided to all functions in addition to tape control. The machine is ideal for drilling, tapping, reaming, etc., a large number of holes of varying diameters to an irregular pattern.

A new horizontal spindle co-ordinate drilling machine has the same drilling area, 6 ft by 6 ft, and drills 1¾ in. dia in steel. It is arranged for automatic drilling by simple or relieving feed cycle, has hydraulic quill feed ½ in. to 10 in. per min, twelve spindle speeds 80–1920 rpm, and is tape controlled to give automatic positioning and automatic spindle cycle. Manual control by push buttons in addition to auto tape control to position the drilling spindle is provided. A vertical table carries tube plates and similar workpieces.

A new rotary automatic drilling machine is capable of drilling, reaming, spot facing and tapping, drilling up to 2¼ in. dia in mild steel. The machine can be arranged in three forms: (a) fully automatic drilling and pitch controlled tapping, with automatic indexing table cycle, (b) fully automatic drilling with automatic indexing table cycle, and manually operated pitch controlled tapping, and (c) fully automatic drilling and indexing cycle, with hand feed for tapping and spot-facing. There are several ranges of spindle speeds, the lowest being 23 to 580 rpm and the highest 60 to 1500 rpm. Indexing is through pick-off gears giving all divisions between 2 and 30. The table is 36 in. dia and the maximum pitch circle diameter of holes drilled is 49 in.

Two machines for dealing with twist drills will be shown. One grinds drills from ¼ in. to 3 in. dia with 2, 3 or 4 flutes. It is available for grinding right- and left-hand drills and with automatic in-feed. Point angles between 80° and 160° can be ground, and the machine is arranged for wet grinding. The other is a machine for web thinning shortened drills and for point thinning drills ground on conventional drill grinders. The tool holder is of universal swivel construction, and adaptor sleeves to carry Nos. 1 to 4 Morse taper drills are provided.

A 50 hp horizontal spindle milling unit, a new machine, is the largest of a range designed to accommodate face cutters up to 28

Archdale 30-in. production milling machine

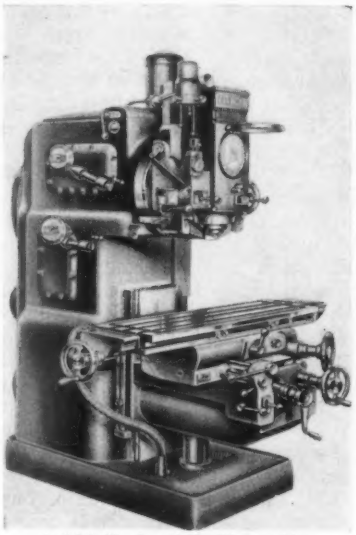
in. dia. The machine has No. 50 taper with No. 60 register, roller bearing spindle, helical gearing, 12 in. dia quill with automatic retraction and clamp, and additional hand axial adjustment for setting. It is arranged for fitting to a slide and for feeding by suitable means. Similarly new is a 25 hp vertical spindle milling unit, one of a range, and designed to accommodate face cutters up to 28 in. dia. It has No. 50 taper with No. 50 register and is intended to be fixed to a column, with a table traversing beneath the cutter. Both this unit and the one above are suitable for heavy milling operations on transfer machines.

The No. 1 horizontal milling machine is a new design having a wider speed and feed range than its predecessor. There are 18 speeds, 30 to 1500 rpm, 18 feeds, 0·85 to 36 ipm. The machine has large diameter overarms, uses climb milling and has either reversible feed and quick traverse to the table only, or with feed and quick traverse to all three table motions.

The same machine also appears with all the features mentioned above but has also a fully automatic table cycle which can be arranged either as a single cycle, or as a repeating cycle for use with automatic indexing fixtures for high production.

The No. 1 vertical milling machine appears in a new design based on the No. 1 horizontal milling machine. This has 18 speeds, 68–3000 rpm, 18 feeds, 1–48 ipm, and 3 hp motor. Reversible feed and quick traverse are provided to all three knee motions and the machine can be supplied with reversible feed and quick traverse to the table only, or with fully automatic table cycle as on the No. 1 horizontal milling machine.

A 30 in. production milling machine is a development of the 24 in. production machine, with 7½ hp motor and the table traverse



Archdale No. 2 vertical milling machine

extended to 30 in., improved and simplified electrical control gear for the automatic table cycle.

The No. 2 vertical milling machine is a powerful 28 in. traverse machine with high spindle speeds and a wide range of speeds and feeds: 24 speeds, 50 to 3000 rpm; 24 feeds, ⅜ to 75 ipm. The swivel head has power feeds and quick power traverse and No. 40 taper. Power feed and quick power traverse are provided to all three table motions and the machine can be supplied with alternative speed ranges of 33–2000 rpm or 25 to 1500 rpm with a 50 taper spindle.

Also to be shown is a Size 2 hydraulic feed universal adjustable multiple spindle drilling machine, representative of a wide range of such machines with drilling capacity 12⅝ in. dia in steel. The area covered by the head is 22 in. by 14 in.

Cutting Tools and Hard Facing

Edgar Allen & Co. Limited, Sheffield, will highlight a number of exhibits on Stand 505 in the Empire Hall, first floor, at the International Machine Tool Exhibition, in a comprehensive display of engineers' cutting tools, form tools and deposit-welded tools, die-steels, alloy-tipped hot-saws, magnetic chucks and examples of progress in powder metallurgy.

Allenite tungsten carbide Plow-rake tools will plane high tensile steel castings, die-blocks, etc., at speeds of 80/100 fpm with ¾ in. (approx.) depth of cut and a feed of 1/32 in. per stroke. The well-known range of Stag Major high-speed steel butt-welded tools, hardened and ready for immediate use, provide freedom from the worries of forging and hardening one's own high-speed steel tools.

Athyweld humped-back deposit-welded parting tools are designed to avoid recurring tool breakage, especially where semi-skilled labour is employed.

Hard-facing materials of various characteristics and analyses, up to 85% tungsten carbide alloys will be shown applied to earth and rock-processing equipment. A method of depositing hard-wearing faces will be exhibited for the first time. The material, deposited on sample components by metal spray process, is not mechanically bonded, but fuse-welded to the parent metal, and its function is to provide a relatively thin but high abrasion-resistant surface. Tests have shown that this process will find many applications in the engineering industry.

The company will also exhibit a wide range of single point cutting tools in cemented tungsten carbide as well as carbide tips and parts in many shapes and sizes. Other exhibits illustrate the Athyweld process applied to the repair of die-castings, and intricate die-casting dies made from Edgar Allen special tool steels are included in this section. Finally, an 18 in. × 36 in. fine pole magnetic chuck with push-button automatic chuck controller will be introduced. It is the product of J. H. Humphreys & Sons Limited, of Oldham, a subsidiary company of Edgar Allen & Co. Limited.

Ultra-precision Gear Hobbing

Two new methods of producing large hobbed gears to limits of accuracy and precision never previously attained will be outstanding features of the David Brown display on stand 49 in the Grand Hall at the International Machine Tool Exhibition.

The machines exhibited are of 140 in. and 30 in. capacity respectively and are equipped with different types of electronic control systems. Their development is the result of long-term research by the David Brown company in conjunction with the National Engineering Laboratory

and the E.M.I. Company.

The David Brown PH30 ultra-precision gear hobber, which is capable of producing gears up to 30 in. dia, incorporates the N.E.L. diffraction grating system designed to check and control the transmission accuracy of the table drive.

The N.E.L. system for accuracy control is fully automatic and does not involve the operator in any way. A circular diffraction grating with 21,600 radial lines is mounted inside the table and another with 180 lines on the worm drive shaft. The ratio of the number of lines is the same as the gear ratio between these two parts. Therefore, the lines pass given stationary points near each grating at the same frequency. Errors in the transmission of the table drive will cause the lines on one grating to advance or retard compared with the lines on the other. By having a light source on one side of each grating and a reference grating and photo-electric cell on the other, sinusoidal electric signals are derived from each unit when the machine is running. By comparing the phase of these signals, the errors of the table transmission are measured.

The error signal is then amplified and utilized in a 'feed-back' to impose fine correction to the transmission through a servo-correcting mechanism. Hence the accuracy is built into the machine and will never vary due to mechanical wear.

All the electrical equipment for the accuracy control system is in a small console (4 ft × 2 ft × 2 ft) which can be remote from the machine, since it is completely automatic and does not involve the operator.

David Brown machines incorporating the system enable the initial accuracy of the table drive to be maintained throughout the working life of the machine. The measuring system has an accuracy of ±1 second of arc which corresponds to 0·00015 in. (0·004 mm) on a 30 in. (760 mm) diameter gear.

The David Brown 140 in. ultra precision turbine gear hobber, which has a maximum capacity of 140 in. gear diameter, is equipped with the Emisyn control system, which is designed to provide a continuous check on indexing accuracy and also to compensate for cumulative errors.

The basic measuring elements of the system are the Inductosyn and Resolver. The Resolver is a signal generator and is driven by the worm drive shaft which comes from the main gearbox. The Inductosyn is mounted in the centre of the table: it consists of a stator supported by the bed and a rotor which turns with the table.

The Resolver produces an electrical signal representing the rotation of the worm drive shaft. Through the mechanical drive, this rotation is also transmitted to the table in the form of rotation or a 'mechanical signal', but includes errors introduced by the gears and the master worm and wormwheel. Thus, when the electrical and mechanical signals are compared at the Inductosyn, the difference represents the errors in the master wheel and other gears in this drive.

The obtaining of a continuous electrical signal of the divide errors of the table drive as the machine is rotating is a very important advancement in gear hobbing machine design. In the David Brown machine, this development is taken a stage further, to the point of amplifying the error signal and utilizing it to impose fine corrections continuously through a servo-motor and correcting mechanism. The accuracy is built in and will be unaffected by mechanical wear.

The Inductosyn consists of two glass discs, rotor and stator, each of which has a silver pattern on one face. The pattern on the rotor forms a continuous printed circuit type coil of 360 radial lines, the two ends of which are connected to the control console through a slip-ring and brush unit. The pattern on the stator has 16 sections, each consisting of a printed circuit type coil of 16 radial lines. The rotor and the stator, with appropriate wiring, forms a 360-pole Inductosyn.

The correction is imposed on the worm drive by axial displacement of a helical gear with respect to the mating gear. The axial displacement is derived from a frictionless, backlash-free, recirculating ball nut and screw which is driven through a spur gearbox from a 100W servo-motor. There is a very high gear ratio from the servo-motor to the table so that a correction of 0·00025 in. at the master wheel is obtained by a 0·1 in. axial displacement of the helical gear or 80 revolutions of the servo-motor.

The accuracy of a machine fitted with this equipment is no longer entirely dependent on the accuracy of the master wormwheel. Accuracy is now derived from the Inductosyn, the maximum accumulative error of which is better than ±2 seconds of arc, which for example corresponds to a maximum of 0·0009 in. at the 95½ in. master wheel diameter of a 3·5 metre machine. British Standard Grade—A allowance (maximum accumulative) for this size of machine is 0·0026 in.

Forging Hammers and Presses

B. & S. Massey Limited, Openshaw, Manchester, 11, England, makers of the world's largest range of forging and drop forging plant, will show six machines at the International Machine Tool Exhibition on Stand No. 26 on the ground floor of the Grand Hall.

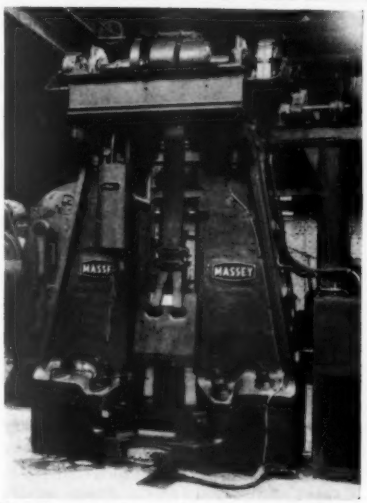
The No. 3 double-acting hydraulic hammer is the first of a range specially designed to give the highest possible output together with the minimum running and maintenance costs. Arduous shop tests have shown that an efficiency in excess of 90% is obtainable, this being greater than any previously claimed for a machine of this type. The hammer is a self-contained unit, electrically driven and a small part of the hydraulic fluid used is employed for slide lubrication. Other than this the actual loss in hydraulic fluid is negligible and only a little "topping-up" is required at regular intervals. Massive standards are of cast iron definitely located on the anvil block; the stroke has been made as short as practicable and the hammer will strike approximately 100 blows per minute although this number may be altered, if desired. The easily adjusted slides make it possible to ensure accurate matching of the dies and the high speed of working to secure maximum production.

The 100 ton "wide ram" trimming and setting press is an addition to the Massey range, designed for preforming and finishing drop forgings in addition to the usual trimming operations. They are made in sizes from 100 ton to 1000 ton with table working areas of from 46 in. × 30 in. in the smaller size to a maximum of 84 in. × 50 in. Each press is provided with four one-piece cast steel pitmans, thus ensuring the maximum resistance to tilting of the ram. All bearings are

of generous proportions and the clutch is of the direct, air operated, friction type as provided on Massey high-speed forging presses and tiebolt trimming presses. The lubrication unit is automatically interlocked with the main press drive so that when the press is in operation, adequate lubrication is provided for all moving parts. Alloy steel double helical gears provide the transmission, and the frame which comprises bedplate, uprights and crown, is of the box type, welded steel construction for maximum strength; the whole frame structure being held together by four large diameter steel bolts which are shrunk into position.

The Massey 10 cwt Marathon drop hammer is already recognized as being one of the most striking developments in gravity fall drop hammer design. It can be supplied in sizes ranging from 10 cwt to 40 cwt and being electrically driven, the running costs are low. The shock-insulated headgear reduces vibration to a minimum and the Fenner torque-arm speed reducing units now employed have brought down consumption and raised the general machine efficiency. They replace the direct V-belt drive and wooden pulleys previously used. Accurate die alignment is ensured by the exceptionally large areas of contact between the standards and anvil block; resilient pads are now fitted not only to the horizontal faces, but also to the vertical faces of the spigots. The recently developed Aeromatic gear which has now, after thorough testing, been adopted as standard, enables the operator to control the hammer by a single pedal which is extremely light in action and provides light or heavy blows of predetermined stroke. Alternatively, when required, the Aeromatic gear can be disconnected and the hammer controlled by hand. The gear may be fitted to new or to many existing hammers of the Marathon and self-contained types.

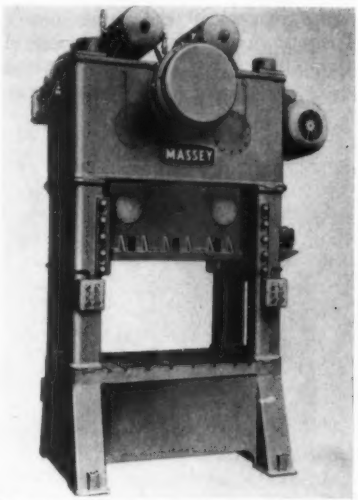
The Massey 1000 ton high-speed forging press has been proved capable of standing up to the most severe three-shift working conditions for long periods at high production speeds with minimum maintenance. This is mainly due to the substantial frame section, as a result of which the maximum energy goes into the making of the component instead of stretching the



The Massey drop hammer has undergone considerable changes in design in recent years

frame. The Massey patented friction clutch is mounted on the eccentric, and the parts to be set in motion and stopped at each stroke are of low inertia. Power consumption, heating of the clutch parts and shock to the frame are therefore reduced to the minimum. The clutch is air cooled and protected against overload. The ram and pitman assembly is dynamically counterbalanced, the pressure in the air balance cylinders rising as the ram approaches the bottom dead centre of its stroke.

The eccentric journals are flood lubricated in addition to the dual interlock lubrication system which makes it impossible for the press to



The wide ram trimming and setting press is the latest addition to the Massey range of forge and drop forging plant

be operated unless the two lubricator motors are running. All movement of the press is governed by the operator working from one central push button panel and top and bottom ejectors are provided to assist production.

The 7 cwt "Clear Space" pneumatic power hammer was first introduced by B. & S. Massey Limited in 1932; since then the general appearance has altered very little although refinements have been introduced. Records show that some 2,000 of these hammers have been supplied, in addition to about 4,000 hammers of the "With Slides" type. The machine is a self-contained unit, motor driven and easily placed in any required position. It is supplied in sizes from 2 cwt to 40 cwt and the smaller sizes (2, 3 and 5 cwt) are provided with a foot lever in addition to the hand lever. The blow energies range from 1460 ft lb to 46,000 ft lb and the ram, which is a single alloy steel forging, heat treated and machined all over, is accurately guided and virtually unbreakable. Lubrication is automatic.

The 3 in. "Use Roller" is the latest means of preparing work rapidly for forging presses and drop hammers, thus allowing the hammer or press to give a maximum output by concentrating on the finished forging. Pre-forming gives a much longer die life and therefore a considerable saving in "down time" for die changing. The machine may be positioned wherever convenient and only requires coupling up to an electric supply. It is operated by pedal and a control panel gives either single strokes or continuous running with an "inch" button for small angular movements. The machine is made in two sizes, namely, $1\frac{1}{2}$ in. and 3 in. to deal with square bar of these sizes.

In addition to the machines mentioned there will also be on display, in model form, a counter-blow hammer from the newly designed range, a Schuler-Massey friction screw press and a double-acting drop hammer of the ram type.

Other machines in the present day range manufactured by B. & S. Massey Limited are solid frame and tiebolt trimming presses: bridge type friction drop hammers: self-contained friction drop hammers: friction drop hammers for light work: steam and air hammers of the arch form and Rigby type.

Double-blow Cold Heading Machines

The range of cold forming machines made by Maschinenfabrik Peltzer & Ehlers, Krefeld, West Germany, has been extended by the recent introduction of a series of six high speed double-blow cold heading machines which handle material from $\frac{1}{16}$ in. to $\frac{5}{8}$ in. dia. The machine shown in the accompanying illustrations is the Model DKP/S6 which will produce bolts or similar components with a maximum shank diameter of $\frac{1}{4}$ in. by 1 in. long with an output of up to 200 pieces per minute.

The application of single blow heading machines is limited by their maximum upsetting capacity. The greatest length of stock which can be upset by a single blow, without the danger of buckling, is 2·5 times its diameter. Heads having a volume larger than 2·5 times the wire diameter must be produced by two blows in a double blow heading machine.

The DKP/S6 machine is driven by a 7·5 hp motor mounted on the machine base and coupled directly to a drive which provides an infinitely variable speed range of 320–1425 rpm. Multiple V-belts transmit power to the large diameter heavy flywheel which is equipped with an effective foot brake for quickly stopping the machine after switching off the motor.

The material is taken from the coil through the adjustable rollers of the straightening device by power driven feed rolls provided with a quick acting pressure release. After being cut off to the required length the blank is transferred to the heading position, where the preforming punch pushes it into the die before exerting the full force of its blow. Simultaneously, the whole or part of the shank can be extruded to the diameter required.

During the next revolution of the crankshaft the finishing punch moves into position in front of the die and completes the heading operation by a single blow. The blank is then ejected from the die, an air jet assisting its downward travel to the chute from which it falls clear of the machine.

A pressure lubrication system delivers oil to all the necessary points on the machine. Surplus oil is caught in a large tray contained within the machine base.

Bolt making machine with an output of 200 pieces per minute

The position of the punch block carrying the preforming and finishing punches is easily and quickly adjusted and resetting of the machine for different wire diameters can be effected within a very short time. An inching button is included in the electrical controls to facilitate setting and adjustment.

The sole United Kingdom selling agents for the machines are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.

New Fortuna Hacksawing Machine

Of heavier construction than the existing range of "Fortuna" hacksawing machines, the new type M01-W is complete with all electrical equipment to be ready for immediate work. Extensive use is made of fabricated steel construction in the cabinet base and bed. The base incorporates coolant tray and suds pump driven off the single motor. The pump belt tension is adjustable and pump speed is always constant despite variations of machine speed.

The new Fortuna hacksawing machine is largely of fabricated steel construction. The base contains motor, pump and suds tray.

Relief is provided on the return stroke by a new type oil dashpot which also provides for variation of cutting pressure on saw blade in addition to alteration in pressure by means of the weight on the slide bar above the saw frame. A release control enables the saw frame to be quickly lowered on to the work.

The drive from the motor inside cabinet base is first by single V-belt and three-step pulleys, belt shifting being done quite simply with the aid of a foot-operated stirrup projecting from the end of the bed. The remainder of the drive is by machine cut reduction gearing of which the pinion is of steel and the gear of best quality cast iron. Generous size teeth are used. The large gear is enclosed by a sheet metal guard in conjunction with the hinged sheet metal belt guard. A limit switch stops the machine automatically on completion of the cut.

The motor, push button starter, limit switch and isolating switch are all mounted on one plate and the whole of the electrical equipment (and suds pump) can be removed from the machine in one unit.

The universal vice is fitted to machined ways in the bed and has vice jaw carriers with square threads. One carrier is tapped right hand and one left hand, and there is a vice spindle threaded to suit. This assures that the work is centered properly in relation to the reciprocation of the saw frame, and also that the vice can be rapidly tightened or loosened. The jaws of the vice are arranged to swivel up to 45°, but owing to the work being thrown out of centre of the saw's reciprocation, the vice spindle can be moved forward (or backwards as the case may be) into various grooves to correct the position of the work.

Considerable economy in saw blade usage is effected by means of the adjustable stroke feature, as it enables 12 in. or 14 in. blades to be used (instead of 14 in. or 16 in. blades, for machines of equivalent capacity). The stroke is adjustable by a hexagon key, and the sheet metal guard which covers connecting rod drive, is hinged to allow easy access when varying length of stroke. The machine is made by the New Fortuna Machine Company Limited, Southmead, Bristol.

Developments in Heat Treatment

There is still a great deal to be discovered regarding the heat-treatment of steels. Some of the points that have been the subject of recent research may at first sight appear abstruse, but it almost always happens that the matters settled eventually produce practical results of advantage to the steel user. In the following notes particulars are given of discoveries made and research attempted during the last few years.

IT has been known for some years that the tempering of medium carbon steels is affected by silicon, but not enough was known regarding the manner in which this element influenced the tempering process. Research was carried out by special methods, and it was eventually established that when silicon is present in the composition of a steel of the type mentioned, considerably higher tempering temperatures are required before it becomes possible to detect the microstructural decomposition marking the third stage of tempering. In fact, these higher temperatures are essential if the second and third stages are to be completed. The diffusion of carbon through the mass of the steel regulates the kinetics of these two stages, but as soon as there is enough silicon present, this control no longer functions in the third stage, the reaction being controlled by silicon diffusion away from the interface.

Another research into tempering was devoted to determining the influence of non-martensite decomposition products on the properties of quenched and tempered steels. The increasing importance of impact properties or notch toughness combined with the discovery that a discrepancy exists concerning an important point, hardenability, made it necessary to decide whether these discrepancies could be explained. It was also sought to know more of the effects of certain microstructural constituents on a steel with a tensile strength of about 106 ton per sq in.

Let us first explain the point regarding hardenability. There is a method of studying hardenability in a steel by measuring the hardness along the length of an end-quenched right circular cylinder. This is known as Jominy hardenability, and the figure derived by measurement is an indication. The difficulty is that steels having the same Jominy hardenability do not always possess the same microstructure hardenability. Microstructure hardenability is an indication obtained by studying the microstructure at different rates of cooling. A diagram is then drawn showing the depth to which a percentage of martensite is formed in quenching a cylinder.

Research established that identical Jominy hardenability figures could be taken as an indication that two steels with the same hardenability figure would effectively perform the same function, as long as the main requirement was *not* notch toughness, but tensile strength. If, however, notch toughness *was* the main requirement, then it was more important to consider microstructure hardenability figures.

Other points brought out in this series of researches were highly technical, but the commercial value of the information gained lies in the discovery that the presence of surprisingly large amounts of lower temperature non-martensitic constituents in a steel of medium carbon type, when slack-quenched and having a bainitic structure, does not greatly injure the mechanical properties. However, there is not yet complete agreement on the conclusions drawn from these researches, and more work remains to be done.

Quenchants, coolants and hardenability have been studied extensively in connexion with hardenability. Since 1939, there have been introduced a mathematical method of predicting the depth of hardness of steels subjected to various forms of quenching; and the Jominy method, earlier mentioned, of using the end-quench bar to measure hardenability. A method has also been developed for calculating hardenability from chemical composition. Work has continued, the object being to examine the quenching constant H and the correlation of cooling rates and hardness in quenched round bars and end-quench bars of low alloy steels. As a result it was found that the constant varied with temperature, the diameter of the bar and the distance from the quenched surface. Better correlation curves were obtained for equivalent cooling positions in rounds and end-quench bars. An improved curve was also obtained for the correlation of the ideal critical diameter D_i with distance, in the end-quench bar.

The more important results of this investigation are that the severity of the quench, H, varies with the factors given above, and that, as was shown, quenching strains affect the rate of transformation and thereby the hardenability.

A valuable contribution to metallurgy has been the development of a unique method of determining the position of the change-points in steel when heated under conditions of high heating rates. It has been shown also that the relative position of the critical points of steel is not fixed, but fluctuates as a function of heating and cooling rates, previous structure, etc. Quenched and tempered structures produce less elevation of critical temperatures at high heating rates, it is stated, than does an annealed pearlitic structure for a specified steel. Tensile stress appears to raise the critical temperatures of steel at high heating rates, while a small tensile stress causes plastic deformation in steel as its temperature is increased or decreased through the critical range.

Temper brittleness is the loss in notched bar impact resistance found in some medium or low alloy steels when tempered within the range 350°–600° C or slowly cooled from a higher tempering temperature. It is revealed by the notched-bar test, but not by the tensile test. The composition of a steel largely decides its liability to temper brittleness, but data were not reliable on this point. Accordingly, a large number of compositions of extreme purity were studied to determine by impact test whether particular elements were more

responsible than others for the temper brittleness of steels. It was found that in a carbon chromium nickel manganese steel, embrittlement was caused by the principal elements, all contributing. Carbon appears to be an important embrittling factor. Manganese, chromium and nickel, reinforce the embrittling effect of carbon, in a degree corresponding to the order in which they are here given. However, there must be more than 4·2% nickel, 2% manganese or 11% chromium for this reinforcing effect to be noticeable. Phosphorus also makes an iron-chromium-carbon steel liable to temper brittleness when it is not in itself susceptible.

Potentially, steel is much stronger than one would think. It has been suggested that it has a tensile strength in the region of 150–160 ton per sq in. whereas in practice steels are only useful at much lower levels. The reason is that when hardened steel is tempered within the range 260–310° C, it becomes to some extent brittle. Researches have been carried out designed to discover means of minimizing, preventing or eliminating embrittlement in steels at high-strength levels. There are, it is stated, three ways by which this result might be achieved. One is by developing special compositions with retarded martensite tempering properties; another, the development of faster tempering speeds to prevent the over-ageing which is known to be a cause of brittleness in alloy steels; and lastly, the development of steels in which high-strength bainite can be produced. A fourth possible approach is a reduction of the tempering temperature to about 200° C with an increase in both toughness and hardness.

The time appears to have come when new alloy constructional steel compositions may, in fact, be developed on a basis other than hardenability alone.

One advantage said to belong to the process known as carbonitriding (a method of producing a hard case on steel by introducing both carbon and nitrogen into the surface at a temperature between 800° and 875° C followed by cooling at a suitable rate) is that the furnaces in which it is carried out have higher proportions of water vapour than are permissible in gas carburizing. Seemingly there is no great demonstratable support for this claim. In consequence, investigations were instituted into the effects of variations in the concentration of water vapour and ammonia on this process. Among the interesting facts elicited are that increasing the concentration of water vapour in the inlet gas lowers the carbon concentration in the case produced, the case depth and the amounts of retained austenite. The reduction in carbon develops a lower surface hardness. If ammonia is present in the carburizing atmosphere, a decrease in water vapour concentration below intermediate values develops a somewhat lower hardness by reason of a larger amount of retained austenite.

The most important results are, however, to show that reduced concentrations of ammonia between 5% and zero appear to bring about a substantial reduction in the nitrogen content of the case; and that reduced concentrations of ammonia bring about a reduction in carbon in the case, particularly at higher dew points. If the dew point exceeds 10° C (50° F) there will be a deposit of soot on the work if high hardness is obtained. The best dew point for the furnace is said to be between 1° and 4·5° C (30° and 40° F). The dew point should be checked in the furnace chamber, and the dew point of the gases should also be determined in the furnace.

When steels are heat-treated to levels of high strength, they sometimes exhibit brittle delayed failures in service, occurring at loads much below those previously sustained and in material believed to possess good ductility. Delayed failure may occur over a wide range of relatively low applied stresses, according to the level of strength, notch sharpness and ageing time after the introduction of hydrogen, introduced into the steel from a variety of sources, and believed to be one of the maior factors in this type of failure.

Research into hydrogen embrittlement has shown that delayed brittle failure under the conditions mentioned can be made to occur in steels electrolytically charged with hydrogen. The sensitivity to this type of failure may continue even after ageing for a period long enough to bring about "full recovery", so that notch tensile strength is a better guide than the tensile test to the actual degree of recovery. When the steel is statically loaded, delayed failure may be the result of a minimum critical stress in the presence of hydrogen, and if it is stressed below this critical value, apparently associated with plastic flow, delayed failure will not take place.

There are two factors to be considered: the depth of hydrogen penetration and an intensity factor or degree of embrittlement associated with concentration. Other important data were also obtained.

We have earlier mentioned research into temper brittleness. Another aspect of this problem is the influence of various alloying elements. Molybdenum and tungsten have been investigated in this respect, and it has been established that they have a complicated effect on the temper brittleness of a 1% chromium, 1% manganese steel. Steels were aged for 1000 hr at different temperatures within the region of temper embrittlement, and the susceptibility to embrittlement was measured from the rise in the transition temperatures. The results are of interest to design engineers concerned with high temperature steels for use in the temperature region 370°–590° C for thousands of hours in steam boilers, turbines, heat-treatment furnaces, chemical plant, etc., ½% molybdenum or 1% tungsten strongly inhibit temper brittleness. This effect diminishes at high percentages. At sufficiently higher temperatures, e.g., 540° C, the equilibrium degree of embrittlement is increased by all Mo and W contents up to 2%. Other results of some importance have also been obtained from these investigations.

Pressure Control

Firth Cleveland Instruments Limited announce a new range of control units for use with pneumatic installations and with gauges, to provide level alarm facilities, and comprising single and double pressure switches, pressure relief valves and lamp enunciators. The single and double pressure switches are available in four models, are capsule operated and have a very simple switch mechanism. Operating pressure can be adjusted to any point within the declared range of the capsule which can withstand pressures up to 50% above the declared range without sustaining change of calibration. The pressure relief valve can be mounted parallel with a pressure capsule-operated indicator or similar device when there is a risk of excessive pressure. Details of casing, etc., are similar to those of the pressure switches. The lamp enunciators are of a mains-voltage long-life type and are designed for good visibility of display at all angles. Fuller details of these control units can be obtained from Firth Cleveland Instruments Limited, Stornoway House, Cleveland Row, London SW1.

Hard Anodizing

Hard anodizing—or deep anodizing—is now an established process for the production of hard, wear and corrosion-resistant surfaces on light alloys. Certain electrical properties of the metal are also enhanced, making the treatment applicable to a wide variety of design applications

HARD anodized aluminium is now accepted as a standard material for mechanical applications such as bearing surfaces or where high wear and erosion-resistance is desired with a lightweight, easily worked material. Lesser known—but equally important in its sphere—is the utilization of the good electrical insulation properties and high heat conductivity of hard anodized aluminium in the electrical industry, e.g., for chassis units mounting power rectifiers and power transistors.

Parts of almost any shape, size or complexity can be hard anodized and the technique can be applied to a variety of light alloys as well as aluminium metal. Thickness of coating deposited may range from 0·002 to 0·004 in. for average applications, up to 0·010 in. or even greater, although there is normally little call for such high values. These compare with the 0·00001 to 0·00002 in. thickness of protective and decorative anodized coatings used in conventional practice.

The anodic coating formed by electrolysis is a surface layer or hard aluminium oxide strongly bonded to the metal surface. The resulting oxide surface has a wear resistance superior to both hard chromium plate and case hardened steel and also has a lower coefficient of friction than the plain metal, so that it is excellent for bearing surfaces or surfaces in rubbing or sliding contact. Comparative wear resistance figures are given in Fig. 1.

The resulting surface is hard and relatively brittle. Some loss of ductility is inevitable on the treated component and little bending or forming can be tolerated without the film cracking, although it will still remain firmly bonded to the parent metal. There may also be a slight reduction in tensile strength of the parent metal and small loss of other mechanical properties, particularly with the heavier coatings. These are minor disadvantages, however, compared with the possible advantages.

The technique of hard anodizing demands high current densities and carefully controlled processing to ensure adequate cooling. Certain alloys may demand special treatment due to their tendency to initiate passive surface coatings inhibiting further oxidization of the surface which may have to be disrupted, e.g., with applied alternating current, in order to achieve the full depth of hard coating required.

The general type of coating produced is slightly rougher than the original surface finish and with a dimensional growth approximately 50% greater than the actual coating thickness. A 0·004 in. coating, for example, applied to a cylindrical object will develop a growth of about 0·002 in. on each surface due to the formation of the oxide coating. The actual figure achieved will vary with the type of alloy and the process employed. The surface can then be finished by grinding, honing or lapping, as called for, aiming at a maximum stock removal of the order of 0·0005 in. to produce a fine microfinish. Growth less allowance for subsequent finishing thus establishes the geometry of the parent metal design. There is no point in aiming to remove more stock than is necessary in final finishing operations because of the labour and cost associated with dealing with such a hard surface.

Casting alloy, or other alloys containing high percentages of copper and silicon are satisfactorily treated by the Hardas process which inherently produced a fine microfinish requiring only a minimum of reworking. The Hardas process, employing very high current densities, is also suitable for building up very thick deposits, should these be called for. Other standard production processes are normally limited to a maximum thickness of deposit of the order of 0·004 to 0·006 in. The main application of thick coatings, e.g., of the order of 0·008 in., is for highly stressed components like screw threads and gear teeth and shoulders.

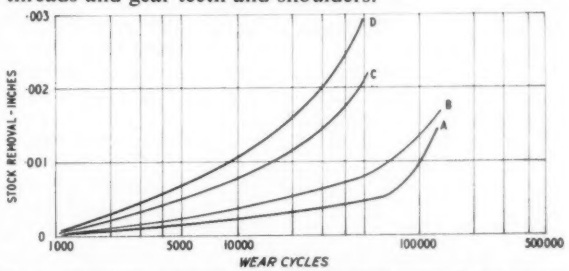


Fig. 1.—Comparative performances of A, hard anodized coating, B, hard chrome plate. C, heat-treated steel and D, aluminium subject to abrasive tests

A useful feature with hard coated screw threads is that anti-seize properties are improved as well as thread strength and resistance to wear. As a bearing surface, however, hard anodized surfaces do not give their best performance with conventional lubricants, although friction is still reasonably low with mineral oils and greases. Better lubricants are molybdenum disulphide, graphite grease, or even water.

Where sliding friction is involved, hard anodized aluminium is highly satisfactory from the wear point of view rubbing against a similar treated surface, or on brass, bronze or steel. Any of these four combinations can be considered satisfactory, the extension to other material combinations being still in the experimental scale. It must be borne in mind, however, that from the strength point of view the limitation is still the strength of the parent metal (aluminium or aluminium alloy) and so high localized loading cannot be tolerated without danger of deflexion and cracking of the hard surface.

Erosion and corrosion resistant properties of hard aluminium coatings may be put to good use in the treatment of light alloy surfaces subjected to hot gases and liquids, particularly where high velocities may also be involved and erosion rate is high with conventional materials. Typical applications in this field include the treatment of high velocity pump and blower parts fabricated in light alloys.

The oxide surface coating is an electrical insulator and the dielectric strength is almost directly proportional to the coating thickness. Thus the degree of insulation required can be controlled by the thickness of coating deposited, breakdown voltages ranging from about 400 volt for thin hard coatings up to 20,000 volt for the thickest deposits. This particular field of application has still largely to be exploited although excellent results have already been achieved with radio and radar chassis units, aluminium wire, insulated clips, etc.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Manufacture of Metallux Resistors

AT its Kembrey Street, Swindon factory, the Plessey Company Limited has set up a special production unit to make Metallux resistors for the electronics industry. Metallux resistors are constructed of a special nickel-chrome alloy deposited on a ceramic former or core by a vacuum deposition process. This process results in a robust and durable film of resistive alloy permanently bonded to the core.

Ceramic formers are received complete with silvered ends ready for production. They are assembled on spools, put into a special carrier and loaded on to the metallizing machine From 100 to 700 resistors can be treated at once depending on the size of the ceramic former.

The carrier holding the formers is placed in a chamber which can be evacuated to 10^{-4} mm/Hg. There the formers are rotated in a horizontal plane, the spools carrying the formers being separately rotated by friction drive as the carriage moves. Four evaporation sources, equally spaced below the carriage, are heated at correct sequence times and alloy deposited on the formers. Masks between sources and formers ensure even distribution of the metal film.

When the deposition process is finished the carriage is removed and a protective coating of silicone varnish is immediately brushed on each resistor. Metallized resistors are then placed on wire carriers and stabilized at high temperature. The resistors are allowed to cool before batch tests are made to establish their temperature coefficient.

The resistance is checked while a heated metal shroud brings the resistors to a temperature of 85°C. Individual resistors are then measured for ohmic value. This resistance value is known as the "pre-value" and resistors are segregated according to their pre-value and temperature coefficient.

The final value of resistors is obtained by grinding a spiral groove through the protective coating and metal film. The resistance is measured as this operation takes place, and the operator stops the traverse of the machine when the correct value has been reached.

Following the grinding operation, wire terminals are added to the resistor elements. A machine is used which crops the wire from the spool, joggles the end and inserts it into the hole in the former. The joggle retains the wire in place by friction until solder has been applied to the wire and the silvered ends of the ceramic former.

Final processing, dependent on the type of resistor required, is usually one of three main methods of treatment—paint protection, ceramic covering and epoxy resin encapsulation.

Finally, resistors are pulse tested to three times the normal rating to ensure no breakdown occurs, then valued and coded.

The vacuum deposition machines used in the production process. The ceramic core is loaded on a special carriage in the vacuum chamber. When the chamber is evacuated an extremely fine, controlled film of metal is deposited on the core

General view of the metallizing section. The three seated operators are loading the ceramic Metallux resistor cores on to special carriages before the metallizing and painting operations. The vacuum deposition machines are seen in the background. (This new production unit has been established for the manufacture of Metallux resistors since the announcement early in 1959 of the agreement between The Plessey Company Limited and Elettronica Metal Lux s.p.a. of Milan)

Pre-treatment of Iron and Steel Components

The pre-treatment plant at the Faringdon factory of Leyland Motors Limited provides corrosion protection for iron and steel bus and truck components. Cast-iron and malleable cast-iron parts are shot-blasted, painted and force dried, and steel components are phosphated. Shot-blasting is carried out by a 4-table Wheelabrator, in which the abrasive is thrown on the iron components by centrifugal force. The components are placed on the revolving circular tables of the machine, the tables themselves being mounted on a revolving base which, when set in motion, carries the

components behind a rubber curtain and through the shot chambers, returning full circle to the loading point.

From the Wheelabrator, the iron components are then placed on a continuous overhead conveyor. This carries them at 4 ft per min past a water wash paint spray booth and through a 15 ft long infra-red stoving oven. They are sprayed with red oxide of iron zinc chromate primer conforming to DEF. 1035B, and passed through the oven at a temperature of 450° F.

Phosphating is carried out by the immersion method, making use of four baths arranged in horseshoe shape served by five 10-cwt electric cranes on an overhead runway. The four baths are gas heated and each has an effective compartment size of 12 ft by 3 ft by 3 ft. Steam is drawn off the tops of the baths by vents alongside and exhausted through a trunking arrangement with a 30 in. dia multi-vane fan.

The steel components for phosphating are first de-greased in a tank which contains trichloroethylene vapour and then placed in a second bath. This contains a phosphating solution conforming to DEF. 29. Independent of bulk, the components are immersed for 20 min at a solution temperature of 210° F, and are given a rust inhibiting coat of iron phosphate. Next come rinses in the two final baths at a temperature of 180° F. After rinsing and drying, the components are transferred to the paint spray conveyor.

Steam Tube as a Boring Bar

Boring large diameter holes either on the lathe or horizontal boring machine, demands the use of a heavy duty boring bar if severe vibration is to be avoided, and though this is, there is also the readily apparent condition of a light bar bending under the strain of a cut; a situation which is yet further amplified when several tools are used. The orthodox boring bar is made from a solid piece of steel and is several feet in length, and in lifting it on and off the machine

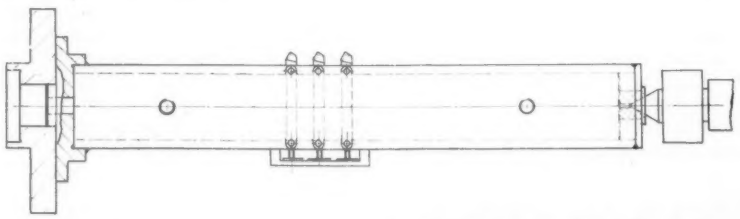


Fig. 1.—Steam tube provides a lighter boring bar without detrimental effects on work finish. Several tools are located on a single bar together with a means of accurately adjusting them

requires the use of a hoist or similar lifting tackle.

The machining of several large cylinders for marine engines raised this problem, and as the work was eventually carried out on a centre lathe, it became necessary to make a special bar which would allow several tools to operate simultaneously without chatter, and yet not weigh too much and so make the work of lifting an awkward operation.

Steam tube is ideal for such equipment because of its rigidity and lightness, and the bore can be used for pumping coolant to the tools.

Location on the machine was the initial consideration, and as the cylinders were to be bored on a lathe, a flange to fit the faceplate provided for both location and holding by counterbored holes was provided for screws. The opposite end was closed by another flanged plate which incorporated a hardened centre portion. The flanges were welded to the tube, the centre insert being dropped while the bar was hot—a shrink grip is more secure than the usual driving fit. The heat will not soften the insert if the latter is made with a thick wall of metal round the conical bearing.

Any number of tools are accommodated in a bar of this design—three are shown here—and to clamp them at both the front and rear ends, bosses were welded on to thicken the tube above the tools and so make it easy to drill and tap it for the holding screws.

The majority of boring bars do not include a means of adjusting the feed to a tool especially when the diameters are small—the size of a hole restricts the fitting of any device outside a bar, and the only means of pushing a tool forward is by using a grub screw behind the cutter. However, a design of this nature means that room is not so important, and the inclusion of a bridge piece as shown for adjusting screws is possible. Each screw is placed in the bridge piece and a washer is soldered or brazed to the screw, the washer being merely to prevent the screw from being withdrawn when turned, and holding it in this way imparts the necessary movement to the tool.

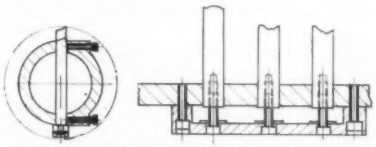


Fig. 2 (left).—Small circular pieces of steel welded to the tube give sufficient thickness for the clamping screws. Fig. 3 (right).—A bridge set behind the tools makes a site for the adjusting screws. The washers are attached to the screws after the latter are placed in position

Two tapped holes spaced well apart along the tube allow the use of eye bolts for the sling, but these holes will require plugging if coolant is pumped through the bore.

Finally, the provision of ground journals at intervals, or the grinding of the whole length, is a matter for consideration and will depend on the class of work undertaken. Such an operation on the bar when carried out concentrically with the location and coned bearing, means that it can run in intermediate bearings set on the machine bed and thus provide an additional support. Such a feature is often advisable when a series of holes are bored through various portions of a casting and spaces are between them; spaces which can be utilized for the placing of these angle plate bearings.

Recording Work Load on Conveyor Systems

A bracket which, when used in conjunction with a Servis recorder, will provide a continuous record of the work done by a belt conveyor over a specified period, has been designed by Mr. M. Davidson, N.C.B. method study engineer in the East Midlands Division. The bracket is designed to suspend a strip of conveyor belting material above the conveyor. This strip of material is allowed to drag on the conveyor, setting up a vibration in the device which varies with the load on the conveyor. These variations are indicated on the chart of the Servis recorder.

The bracket consists of an upright member of mild steel angle bar to which is bolted a foot plate that can

be bolted to the conveyor structure. Provision of a series of footplates enables the bracket to be used on a variety of conveyor structures by employing the appropriate plate. At the top of the upright member a piece of 1-$\frac{3}{8}$ in. o.d. seamless conduit is welded horizontally in such a position that the centre line of the conduit passes across the conveyor at right angles to the line of travel.

A mild steel rod passes through this conduit. At one end of this rod is suspended the strip of belting material; at the other end a mild steel face plate is welded in such a way that the rod is axial to the plate. Two collars at either end of the conduit hold the rod in position and permit movement of the rod relative to the conduit when lining up the device. The strip of belting material should drag a maximum of three inches on the empty belt.

When a Servis recorder is fitted to the bracket three different lines appear on the recorder chart after a normal running cycle. A straight thin line indicates that the conveyor is standing; a thick line indicates that the conveyor is carrying material, the thickness of the line being a rough guide to the amount of material being carried; and a thin wavy line shows that the conveyor is running light.

Distance Piece for Pneumatic Controller

An adjustable distance piece which facilitates the testing of Worsley Mesnes pneumatic controllers has been designed by Mr. S. Edwards, N.C.B. unit mechanical engineer at Swanwick Colliery, E. Midlands Division.

When testing winding engine control gear of this type it is necessary to arrange for the overwind trip of the controller to be actuated at an earlier point than when the engine is running normally. The placing of a distance piece on the appropriate thread of the controller has the effect of tripping the braking mechanism at an earlier point in the wind than when the distance piece is not present.

The device is simply a hinged steel collar, $1\frac{1}{4}$ in. thick, with an inside diameter of $1\frac{5}{8}$ in. and an outside diameter of 3 in. A securing pin is provided to fix it in position.

The point in the wind at which the controller begins to brake the engine depends upon the thickness of the distance piece, and by providing three screwed pins on one face of the collar, Mr. Edwards has in effect made this thickness adjustable. The collar is tapped to receive these studs, and locking studs are provided to fix the pins firmly in position when they have been adjusted to give an overwind trip at the desired point in the wind.

Buckling Column Springs

The greater portion of the load-deflexion characteristics of a thin strip of steel, loaded as a round-ended column, may be utilized in spring design where low rate and relatively large deflexions are specified. This has been shown by theoretical and experimental studies made at the Research Centre of the Associated Spring Corporation, Bristol, Connecticut, U.S.A. The full[1] analysis, the design formulae and working charts are given by Alexander Blake, Head of the Applied Mechanics Section of the Research Centre, in a paper (No. 60-SA-10) presented this year to the Machine Design Division of the American Society of Mechanical Engineers.

The final design equation for the calculation of load-deflexion characteristics for a buckling column spring (Fig. 1) along the x-axis is given as:

$$P = AE\Psi/m^2 \qquad (1)$$

where P = working load, lb
A = cross sectional area of buckling column spring, sq. in.
E = modulus of elasticity, psi
$m = L/h$
where L = free length of buckling column, in.
h = thickness of stock, in.
Ψ = factor for load calculation.

Factor Ψ is defined as a function of
$\epsilon = \delta/L$
where δ = deflexion in direction of buckling load.

and, as indicated by the curve in Fig. 2, may be approximated by a straight line relationship between the values $\epsilon = 0{\cdot}05$ to $0{\cdot}40$, which are recommended as practical design limits for a buckling column spring. There is a unique relationship between the lengthwise and lateral deflexions for which a simple design chart is shown in Fig. 3. This design aid permits rapid prediction of lateral deflexion N when δ is either calculated or assigned.

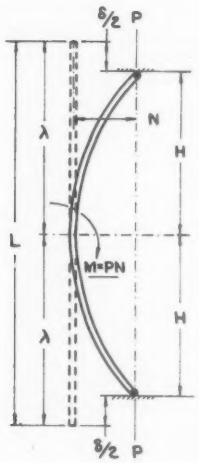


Fig. 1 (left).—Buckling column spring of uniform rectangular cross section is shown in deflected position between the pivoted ends

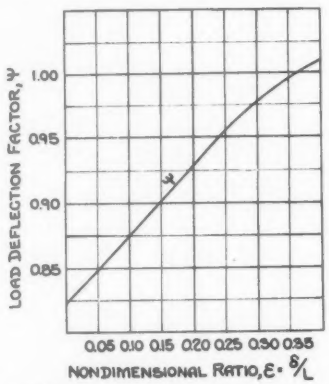


Fig. 2 (centre)—Factor for calculation of load deflexion characteristics for a buckling column spring

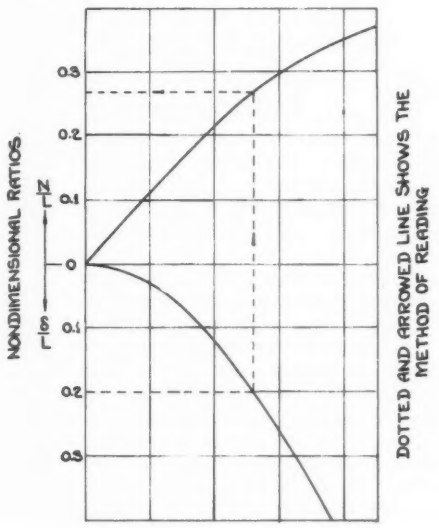


Fig. 3 (right).—Nondimensional chart for finding lateral deflexion of a buckling column spring when longitudinal deflexion δ is given

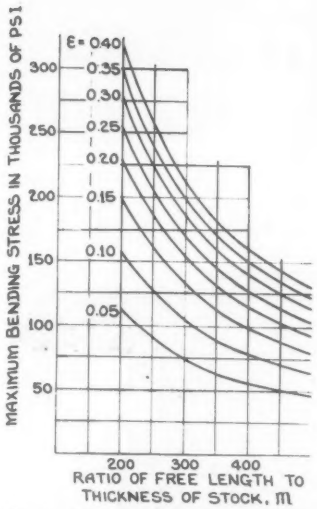


Fig. 4.—Calculated maximum bending stresses in buckling column springs for range of recommended values of ϵ and m. Modulus of elasticity, E = 30 $\times 10^6$ psi

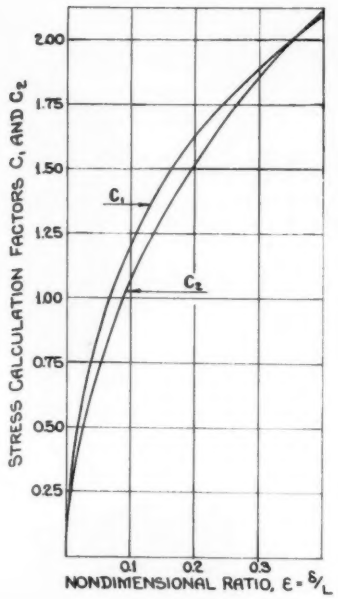


Fig. 5 (right).—Factors for computation of maximum bending stresses of a buckling column spring

When a simple flat column is compressed between the pivoted ends appreciable bending stress may develop even for a moderate load capacity. Whereas the derivation of the design formulas for deflexion cannot be based on the theory of deflexion, an idea of the maximum bending stresses may be had by using elementary beam analysis. Assuming that the maximum bending moment increases in direct proportion to lateral displacement,

$$M = PN \qquad (2)$$

where M = bending moment, lb-in.
N = maximum lateral displacement,

in the elementary strength of materials theory shows that the bending stress is $\sigma = M/Z$, where Z denotes section modulus. Hence using equation (2) and section modulus for a rectagular cross section, we obtain:

$$\sigma = PmC_1/A \qquad (3)$$

The working load P may be eliminated with the aid of equation (1) to given an alternative design formula for stress as follows:

$$\sigma = EC_2/m \qquad (4)$$

In order to facilitate stress calculations, design curves are given in Fig. 3, illustrating the variation of stress factors C_1 and C_2 with nondimensional ratio ϵ.

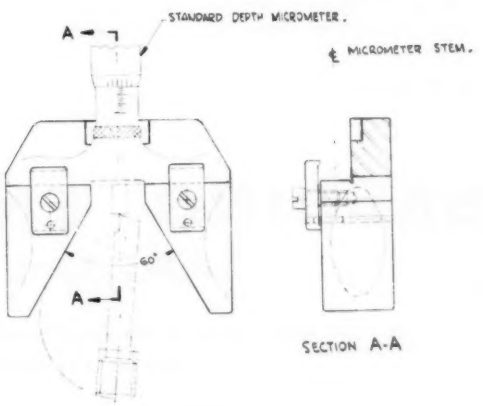
An auxiliary diagram for selection of stress levels in buckling column springs made of steel strip is shown in Fig. 4. These curves were calculated for a value of $E = 30 \times 10^6$ psi, using formula (4) and the design chart in Fig. 5. The curves cover the working range with practical limiting values of ϵ and m which correspond to buckling column springs investigated.

Tool for Setting Boring Bar Cutters

Accurate setting of cutters held in boring bars can be readily accomplished by using the V-block, illustrated, in conjunction with a standard depth micrometer held in position by the two clamps. The included angle of the V is made 60° so that the movement of the micrometer stem will be exactly the same as the movement of the cutter. This eliminates the calculation that is necessary.

When a 90° V is used, for a micrometer range of 0 in. to 1 in., the opening of the V should be approximately $2\frac{1}{2}$ in., and the distance up to the surface where the micrometer base rests should be approximately $1\frac{29}{32}$ in. With these dimensions a maximum bar of $2\frac{3}{4}$ in. dia can be checked. As an example of the application of the tool, assume that it is required to set the cutter in a 2·250 in. dia bar for a hole of 2·878 in. dia. The amount the cutter projects from the bar will be one-half the difference between 2·878 in. and 2·250 in. or 0·314 in. A reading is taken on the bar and 0·314 in. subtracted from it in order to get the reading necessary for setting the cutter to 2·878 in. dia. As there are factors that can affect the diameter of a hole produced by a cutter held in a boring bar, it is better to set the cutter undersize for the first hole; take a trial cut, check it, and then make the final setting based on the diameter produced by the trial cut. By following this procedure, the first hole will not be bored oversize.—

GENE MURRAY.



Tool for setting boring bar cutters

Aircraft Lofting

The process of full-scale lofting was introduced into the aircraft industry during the second World War and Short Brothers & Harland Limited were one of the first aircraft companies to adopt it, and they have since used it successfully on all major design projects. For work on the SC5 Britannic freighter, the fuselage of which is 136 ft long and 17 ft 7 in. dia, the departmental layout had to be rearranged to accommodate the large tables required—up to 120 ft × 20 ft. The full-scale drawings are made directly on to metal sheets, and from these duplicates are turned out lithographically on metal for making templates for the use of the works.

Nuclear Research and Power Reactors in Euratom Countries

The third and concluding part of a review of the progress made with research and power reactors

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

1.2.6 The Organization for European Economic Co-operation (O.E.E.C.)

O.E.E.C. was established on April 16, 1948, and its first task was to propose a recovery programme and to allocate amongst its members the aid granted by the United States Congress in Europe. The original 17 member countries were:

Austria	Iceland	Portugal
Belgium	Ireland	Sweden
Denmark	Italy	Switzerland
France	Luxembourg	Turkey
West Germany	Netherlands	United Kingdom
Greece	Norway	

The United Kingdom was the first to sign the treaty on June 10, 1948, and Greece was last on October 20, 1949.

(a) Associate members are Canada and United States.

(b) Spain participates as a full member on an equal footing with the member countries in the work of agricultural bodies of the organization and is associated in the other activities.

(c) Yugoslavia is represented by an observer and also participates in the work.

The primary purpose of O.E.E.C. is summarized below:

(a) To combine economic strength

Table XVIII.—SUMMARY OF WEST GERMAN RESEARCH AND TEST REACTORS

1	2	3	4	5	6	7	8	9	10	11	12
Item	Owner	Design by	Location	Operator	Type	Design Power (thermal)	Fuel	Moderator	Coolant	Date first critical	Date on full power
1	Technical University (Munich)	A.M.F. Atomic	Garching near Munich	Technical University (Munich)	Pool type (heterogeneous water moderated 20% enriched U235)	kW 1000	20% enriched uranium U235	light water	light water	31.10.57.	—
2	University of Frankfurt	A.M.F. (components) Farben-fabrik Hoecht (assembly and shielding)	Frankfurt	Johann Wolfgang Goethe University	Solution type (uranyl-sulphate in water (20%)	50	uranyl-sulphate in water (20%)	light water	light water	10.1.58.	—
3	Institut für Kern-forschung (Berlin)	—	West Berlin (University)	Institut für Kern-forschung (Berlin)	Solution type (uranyl-sulphate in water 20%) (BER)	50	uranyl-sulphate in water (20%)	light water	light water	24.7.58.	Aug. 58.
4	Gesellschaft für Kernener-gieverwert-ung in Schiffbau und Schiff-fahrt, m.b.H.	Babcock & Wilcox Deutsche B & W Dampf-kessel-werke	Normannen-weg, near Hamburg	Technical University Hamburg	Pool type (heterogeneous 20% enriched U235 light water moderated and cooled)	5000	20% enriched uranium U235	light water	light water	Sept. 58	—
5	Siemens-Schuckert-werke	Siemens-Schuckert-werke	Garsching near Munich	Siemens-Schuckert-werke-	Argonaut type (heterogeneous natural uranium graphite moderated light water cooled)	—	natural uranium	graphite	light water	—	1960
6	Nordrheim-Westfalen	A.E.I.-J. Thompson	Julich near Cologne	—	Merlin type (heterogeneous light water moderated highly enriched 93% U235) (tank type)	5000	enriched 93% U235	light water	light water	—	1959
7	Nordrhein-Westfalen	Head Wrightson Processes	Julich near Cologne	—	Dido type (enriched uranium heavy water moderated)	10,000	enriched uranium	heavy water	heavy water	—	1961
8	Die Kern-reaktor Bau und Betriebs group	Siemens Schuckert werke	Karlsruhe	—	Argonaut type (heavy water cooled and moderated natural uranium)	10,000 to 12,000	natural uranium	heavy water	heavy water	—	—
9	Nordrhein-Westfalen	Krupp-Brown Boveri	Stetternich near Julich west of Cologne	—	High temperature type	10,000	—	—	—	—	1961

Towards the end of the nineteenth century Buck & Hickman, having obtained the Sole Agency in this Country for Brown & Sharpe and Pratt & Whitney Companies, imported many automatic production machines which were introduced to the Cycle industry at the Crystal Palace Exhibition in 1896, and eventually to the Automobile industry at subsequent exhibitions at the Agricultural Hall, thus Buck & Hickman were instrumental in introducing into this Country the mass production methods now commonly practised in industry.

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Bullard Machine Co.
Foote-Burt Co.
Garrison Chuck Co.
Gleason Works
Jones & Lamson Machine Co.
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(b) To make fullest collective use of individual capacities and potentialities
(c) To increase production
(d) To develop and modernize industrial and agricultural equipment
(e) To expand commerce
(f) To reduce progressively barriers to trade
(g) To promote full employment
(i) To restore or maintain economic stability and general confidence in national currencies.

The European Nuclear Energy Agency and the Eurochemic were sponsored by the O.E.E.C.

1.2.7. International Atomic Energy Agency (I.A.E.A.)

The establishment of an international atomic energy agency was first proposed by President Eisenhower in a speech to the United Nations in New York on December 8, 1953. He gave the assurance that the United States would co-operate with many nations in the development of the peaceful use of nuclear energy. In October, 1956, the Statute of the I.A.E.A. was published. It was accepted without amendment, and representatives of 80 countries signed the agreement, which came into force officially on July 29, 1957. The first general conference was held at the headquarters in Vienna in October, 1957, and 62 nations sent delegates. The agency's first eight months of operation, from October, 1957, to the end of June, 1958, was contained in a report presented to the second session of the general conference in Vienna on September 22, 1958. A similar meeting was held in 1959.

The principal aims of the I.A.E.A. are:

(a) To supply fissionable and source materials
(b) To help to ensure fuel supplies for atomic energy programmes
(c) To provide technical assistance through expert advice
(d) To grant fellowships
(e) To arrange for the exchange of scientists and experts
(f) To hold conferences
(g) To arrange international training programmes
(h) To establish a scientific and technical documentation service
(i) To survey the problem of standardized terminology in nuclear physics and engineering in various languages
(j) To publish an international reactor dictionary on all types of power, research and training reactors now in existence or under construction
(k) To prepare a manual on the safe practice in the use of radioisotopes.

1.2.7.1. Scale of members' contributions to I.A.E.A. in 1959

The assessment for the members' contributions to the agency's regular budget for the financial year, 1959, is based on a scale adopted by the General Assembly of the

Table XIX.—ESSENTIAL PARTICULARS OF WEST GERMAN RESEARCH REACTORS

1	2	3	4	5	6
		Technical University of Munich	University of Frankfurt	Institute fur Kernforschung (Berlin)	Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H. (Hamburg)
1	Designation	FRM	—	BER	—
2	Location	Garching	Frankfurt	West Berlin	Hamburg
3	Type of reactor	Pool type	Solution type	Solution type	Pool type
4	Rating of reactor (thermal)	1000 kW	50 kW	50 kW	5000 kW
5	Date first critical	31.10.57	10.1.58	24.7.58	—
6	Moderator	light water	light water	light water	light water
7	Coolant	light water	light water	light water	light water
8	Fuel				
	a. Type	uranium U235	uranyl sulphate	uranyl sulphate	uranium U235
	b. Enrichment (%)	20	—	20	—
	c. Minimum critical mass (Kg)	3·5	1·19	1·175	3·85
	d. Initial charge (kg)	4·2	1·31	1·31	4·35
	e. Specific rating (kW/kg U235)	238	38	38·0	1116
	f. Expected average burn up before reprocessing	20%	—	—	15·0%
9	Fuel element				
	a. Shape	curved plate	Not applicable	Not applicable	parallel plate (MTR)
	b. Alloy	U–Al alloy	,,	,,	45% (wt)uranium in alumnium
	c. Cladding thickness (in.)	0·015	,,	,,	0·015
	d. Cladding material	aluminium	,,	,,	aluminium
	e. Number of fuel elements per subassembly	12	,,	,,	—
	f. Number of subassemblies	24	,,	,,	—
	g. Total number of fuel elements	288	,,	,,	—
	h. Dimensions of fuel elements	2·5 in. × 0·020 in. 23·6 in.	,,	,,	2·5 in. × 0·020 in. × 23·5 in.
	i. Dimensions of subassembly	3 in. × 3·16 in. + 34⅜ in.	—	—	3 in. × 3 in. × 34⅜ in.
	j. Normal life of subassembly	27MWD/element	—	—	—
10.	Core				
	a. Overall dimensions	13 in. × 18 in. × 24 in.	15¾ in. sphere	15¾ in. sphere	15·2 in. × 19·1 in. × 24 in. high
11	Containment vessel				
	a. Shape	pool type	sphere	sphere	pool
	b. Dimensions				
	diameter	—	15¾ in.	15¾ in.	—
	length or height	21 ft	—	—	30 ft 3 in.
	width	27 ft	—	—	23 ft
	breadth	20 ft	—	—	23 ft
	c. Material	—	stainless steel	stainless steel	concrete
	d. Mean operating pressure	head of water in pool	14 psia	13 psia	atmospheric
	e. Mean operating temperature (° F)	100	176	176	—
12	Primary coolant through core				
	a. Normal flow (gpm)	900	13	13	—
	b. Mean velocity (ft/sec)	1·5	15	15	—
	c. Inlet temperature (° F)	100	60	60	—
	d. Outlet temperature (° F)	108	100 approx.)	100	—
	e. Rise in temperature (°F)	8	40	40	—
	f. Average core heat flow (BTHU/ft²/hr)	12,200	—	—	—
13	Reflector	water	graphite	graphite	—
14	Biological shield	concrete	croncete	concrete	water and concrete
15	Method of heat dissipation	heat exchanger	—	—	heat exchanger

Table XX.—WEST GERMAN NUCLEAR POWER STATIONS UNDER CONSTRUCTION AND PLANNED

1	2	3	4	5	6	7	8	9	10	11
Item	Owner	Designer	Location	Type of reactor	Rating (Electrical)	Fuel	Moderator	Coolant	Year in operation	Remarks
					MW					
1	Rheinische-Westfalische Elektrizitats-werke (RWE)	International General Electric, U.S.A. (main contractor) A.E.G. and Hochtief, AG	Kahl on Main near Frankfurt	BWR	15	uranium dioxide supplied by Mallinckroft Nuclear Corporation, U.S.A. (6·4 ton of 2·6% enriched UO_2	light water (1470 psi)	light water (1470 psi)	1960	First German nuclear power station
2	Arbeitsgemeinschaft deutscher Energieversorgungsunternehmen zur Vorbereitung der Errichtung eines Leistungsversuchsreaktor (A.V.R.) e.V. Düsseldorf)	Krupp-Brown Boveri	Stetternich near Julich, west of Cologne	Homogeneous gas cooled graphite moderated enriched uranium. (High temperature pebble-bed design)	15	ceramic, 20% enriched uranium monocarbide mixed with graphite. (The fuel element consists of graphite pellets sealed with bounded graphite plugs	graphite	mixture of 22% helium and 78% neon gases	1961	Second German nuclear power station and first to be designed and manufactured entirely by German firms. Ten cities sharing with Federal Government cost of £3·3 million, half borne by Government. Closed circuit incorporates a gas turbine as the power generated plant.
3	Gesellschaft fur die Entwicklung der Atomkraft in Bayern m.b.H. (Atomkraft Bayern)	Siemens-Schuckert, AG (SSW)	—	Natural uranium heavy water moderated and cooled (as Canada's NPD) (SNDRI)	100	natural uranium	heavy water	heavy water	1962	Bavarian State and Farbenwerk Hoechst have joint interest with Siemens group. Design will be based on Siemens natural uranium DO_2 reactor (SNDR1). Contract placed Feb. 1959.
4	—	A.E.G. and German Babcock and Wilcox	—	BWR	100 to 150	enriched uranium	light water	light water	—	Federal Government to give subsidies of DM4 M (£330,000) each to the two firms for construction of experimental power station of 100—150 MW (electric)

Table XXI.—PARTICULARS OF ITALIAN RESEARCH REACTORS

1	2	3	4	5
		Enrico Fermi Institute of Nuclear Studies	Comitato Nationale per le Ricerche Nucleari (C.N.R.N.)	Societa Ricerche Impianti Nucleari
1	Designation	—	—	Sorin
2	Location	Milan	Ispra, near Milan	Saluggia, near Milan
3	Type of reactor	solution (uranyl sulphate in water) (20%)	heterogeneous enriched uranium heavy water moderated and cooled	heterogeneous enriched uranium light water moderated and cooled
4	Rating of reactor (thermal) kW	50	5000	1000
5	Date first critical	Feb. 1959	early 1959	early 1959
6	Date on full rating	—	—	1959
7	Moderator	light water	heavy water	light water
8	Coolant	light water	heavy water	light water
9	Fuel			
	a Type	uranyl sulphate	enriched uranium	enriched uranium
	b Enrichment (%)	20	20	20
	c Normal fuel charge (kg U235)	1·17	2·2	4·2
	d Specific rating (kW/kg U235)	42·7	2273	237
	e Expected average burn up before reprocessing	—	20 to 30% U235	20%
10	Fuel element			
	a Type	not applicable	curved plates	curved plates
	b Fuel alloy or composition	,,	45% U–Al alloy	U–Al alloy containing 14·8 gm U235 per plate
	c Cladding thickness	,,	0·017 in.	0·015 in.
	d Cladding material	,,	aluminium	aluminium
	e Type of subassembly	,,	parallel plates	parallel plates
	f Number of fuel elements per subassembly	,,	18 plates	12 plates
	g Number of subassemblies	,,	15	24
	h Total number of fuel elements	,,	270	288
	i Dimensions of fuel element	,,	2·5 in. × 0·026 in. × 23·625 in.	2·5 in. × 0·026 in. × 23·6 in.
	j Dimensions of the subassembly	,,	3 in. × $3\frac{1}{16}$ in. × 31·375 in.	3 in. × 3·16 in. × 34·375 in.
	k Normal life of subassembly	,,	13 weeks	27 MWD/element
11	Core			
	a Overall dimension of active core	$15\frac{1}{2}$ in. (sphere)	31 in. dia, 23·375 in. high	13 in. × 18 in. × 24 in.
12	Core containment vessel			
	a Overall dimensions	$15\frac{1}{2}$ in. (sphere)	4 ft dia. 7 ft high	37 ft × 20 ft × 31 ft (deep) (pool)
	b material	stainless steel	aluminium	walls approx. 6 ft concrete
	c Mean operating pressure	13 psia	about atmospheric	head of water in pool
	d Mean operating temperature (°F)	176	104	100
13	Primary coolant through core			
	a Type of coolant	light water	heavy water	light water
	b Normal flow	13 gpm	700 gpm	900 gpm
	c Mean velocity (ft/sec)	15	5	1·5
	d Inlet temperature (°F)	60	90	100
	e Outlet temperature (°F)	100	104	108
	f Rise in temperature (°F)	40	14	8
14	Method of heat dissipation	through coils within the core	heat exchanger	shell and tube heat exchanger
15	Biological shield	concrete	magnetite and concrete	concrete

INTERNATION

United Nations for 1959 to 1961, at a meeting on October 2, 1959. There are 70 nations that contribute to this yearly budget and each has to give a specified percentage of the total, as indicated, for the principal countries of the world, in Table XIII.

The first 17 nations are also members of O.E.E.C. and their contributions amount to 26·99%. The total sum contributed by the above 23 members corresponds to 85·55% of the yearly budget. The other 47 countries make up 14·45%. United Kingdom's value is 7·22% and the United States gives 32·51%, i.e., $\frac{1}{3}$ of the total.

The budget for 1958 is presented below:

(a)	Total assessed contributions from member States	$4,114,760
(b)	Total income received	$4,120,875
(c)	Total expenditure	$3,867,786
(d)	Gross surplus (b)—(c)	$253,089

The approved administrative budget for the year 1959 is $5,225,000 (about £1·88 M.) and the Work Capital Fund is to remain $2,000,000, (£725,000).

1.2.8. European Coal and Steel Community (E.C.S.C.)

The initial proposal for the direct control of the two basic industries, coal and steel, by an international body was made by M. Schuman of France on May 9, 1950. The main object was to place under a common authority the resources of French and German coal and steel, in an organization open to other European countries. In April, 1951, the European Coal and Steel Community was formed by the Benelux countries (Belgium, Netherlands and Luxembourg), France, West Germany and Italy. The Benelux Customs Union was signed in September, 1944, and came into effect in January, 1948. These six member nations, known as "Common Market Countries" agreed at a conference in Rome on March 25, 1957, to form the European Atomic Energy Community, i.e., "Euratom". It is of special interest to add that the British Government was not prepared to accept either the ultimate political objective of the community or transfer the control of the British coal and steel industries which was stipulated for membership of the new organization.

1.2.9. European Free Trade Association (E.F.T.A.)

At the convention in Stockholm on November 20, 1959, the treaty of E.F.T.A. was initialled by representatives of the seven countries, Austria, Denmark, Norway, Portugal, Sweden, Switzerland and United Kingdom. Britain signed the European Free Trade Association Convention in London on December 29. It is to come into force on July 1, 1960. The primary objectives are economic expansion within the area and greater trade during the next ten years by removing the barriers to trade between the industries of the seven countries. The population of the area covered is about 90 million people against 160 million in the common market countries.

A notable decision was made by the six nations of the European Common Market at Strasbourg on November 24, 1959, four days after the European Free Trade Association's agreement in Stockholm. It was agreed to extend their trading privileges to other western nations outside their community including Britain and the United States. This offer must be regarded as a welcome step towards forming a bridge between the Common Market and the "Outer Seven". This would certainly stimulate world trade and improve the political and the economic situation in Europe at the same time.

Table XXII.—SUMMARY OF THE ESSENTIAL PARTICULARS OF FIRST ITALIAN NUCLEAR POWER STATION (LATINA)

1	Owner	SIMEA
2	Designer and manufacturer	Nuclear Power Plant Co. & AGIP Nucleare
3	Location	Foce Verde (near Latina)
4	Year of commissioning	1962
5	Type of reactor	natural uranium graphite moderated and CO_2 cooled (Calder Hall type)
6	General	
	a Number of reactors	1
	b Number of circulators	6
	c Number of heat exchangers	6
	d Number of main turbogenerators	3
	e Number of auxiliary turbogenerators	2
	f Number of loops per reactor	6
7	Ratings	
	a Thermal rating of reactor	705 MW
	b Net electrical output from the station	200 MW
	c Maximum rating of each main turbogenerator	70 MW
	d Maximum rating of each auxiliary turbogenerator	9·5 MW
8	Fuel	natural uranium
9	Fuel elements	
	a Diameter of fuel rods	29·3 mm (1·153 in.)
	b Length of fuel rods	914·4 mm (36 in.)
	c Number of fuel rods per channel	8
	d Number of channels	2853
	e Number of fuel rods (total)	22824
	f Diameter of fuel channel	105 mm (4·13 in.)
	g Total weight of fuel	262·5 tonne
	h Maximum fuel temperature	585° C (1085° F)
	i Cladding material	Magnox A.12
	j Cladding thickness	2 mm (0·078 in.)
	k Diameter over the fins	57·2 mm (2·25 in.)
	l Type of fin	helical
10	Moderator	graphite–A type
11	Core	
	a Diameter	12·71 m (41 ft 8·25 in.)
	b Height (active)	7·82 m (25 ft 8 in.)
	c Overall diameter (including reflector)	14·25 m (46 ft 3 in.)
	d Overall height (including reflector)	9·45 m (31 ft)
	e Average temperature	306° C (582·8° F)
12	Reactor vessel	
	a Mean diameter of sphere	20·35m (66 ft 9 in.)
	b Thickness of plate	90 mm 3·543 in.
	c Total weight	1636 tonne
	d Operating pressure	12·8 kg/cm (102 psi.)
13	Coolant	Carbon dioxide
	a Inlet temperature	180 °C (356°F)
	b Outlet temperature	390° C (734° F)
	c Temperature rise	210° C (378° F)
	d Number of circulators	6
14	Control	
	a Number of channels for coarse control	91
	b Number of channels for fine control	9
	c Total number of channels for control	100
	d Material of control rods (inserted in steel tubes)	ferro-boron
	e Length of control rods	8·35 m
15	Shielding	
	a Density of concrete	140 lb/cu ft
	b Thickness (minimum/maximum)	8 ft 5 in./8ft 6 in.
	c Cooling medium	air
16	Heat exchanger	
	a Number	6
	b Type of tube	Tru-well (helical fin)
	c Bore of tube	1·646 in.
	d Root diameter of fin	2·002 in.
	e Outside diameter of the fin	2·821 in.
	f Thickness of fin	0·057 in.
	g Number of fins per foot	64
	h Steam conditions after heat exchangers	
	H.P. pressure	788 psia
	H.P. temperature	703·4°F
	L.P. pressure	221·5 psia
	L.P. temperature	703·4° F
17	Main turbogenerator	
	a Number	3
	b Maximum rating	70 MW
	c Speed	3000 rpm
	d Voltage of generator	11·8 kV
	e Efficiency of generator	98·0%
18	Steam conditions at the turbine	
	a H.P. pressure at stop valve	745 psia
	b H.P. temperature at stop valve	704° F
	c L.P. pressure at inlet	203·3 psia
	d L.P. temperature at inlet	704° F
	e Final feed temperature	190° F
19	Auxiliary turbogenerators	
	a Number	2
	b Maximum rating	9·5 MW
	c Speed	2250 rpm

1.2.9. Members of the Various European and International organizations

Such a list is presented in Table XIV. The total number of members of each group is indicated in Table XV.

1.2.10. Essential particulars of research and power reactors installed or under construction in "Euratom" countries

This information is briefly summarized for the reactors in Belgium, France, The Netherlands, West Germany, and Italy in the following tables:

A. Belgium

(1) Research reactors
BR–1, BR–2 at Mol, near Antwerp — Table XVI, Cols. 3, 4

(2) Power reactor
Belgium's first nuclear power station at Mol. — Table XVII

B. France

(1) Research reactors
EI–2 and EI–3 at Saclay and Melusine — Table XVI, Cols. 5, 6
(Grenoble) — Table XVI, Col. 7

(2) Power reactors
G1, G2 and G3 at Marcoule
EDF1 and EDF2 at Avoine
These particulars were published by the author in MECHANICAL WORLD, December, 1959, Table III.

C. The Netherlands

(1) Research reactors
A–57 (Delft), HFR (St. Maartenszer, near Petten) — Table XVI, Cols. 8, 9, 10

D. Federal Republic of Germany

(1) Research reactors
A summary of nine — Table XVIII
The essential particulars of four (Munich, Frankfurt, Berlin, and Hamburg) — Table XIX

(2) Power reactors
A summary of four reactors for power stations — Table XX

E. Italy

(1) Research reactors
One each at Milan, Ispra and Saluggia near Milan — Table XXI

(2) Power reactors
A summary of essential particulars of Italy's first nuclear power station (Latina) — Table XXII
Particulars of six nuclear power stations under construction and planned — Table XXIII
List of establishments and companies associated with nuclear research and power stations — Table XXIV

In conclusion a summary of the types of research reactors installed or under construction in Euratom countries (1956–1959) is presented in Table XXV.

Table XXIV.—ESTABLISHMENTS AND COMPANIES ASSOCIATED WITH NUCLEAR RESEARCH AND NUCLEAR POWER STATIONS IN ITALY

1	Centro Informazione Studi Esperienze (1946)	C.I.S.E.
2	Ente Nazionale Idrocarburi (Rome)	E.N.I.
3	Comitato Nazionale per di Ricerche Nucleari (1952) Co-ordination of fundamental and applied research in the nuclear field	C.N.R.N.
4	Societa Elettronucleare Nazionale	S.E.N.N.
5	Agip Nucleare (subsidiary of E.N.I.)	AGIP
6	Societa Italiana Meridionale per l'Energia Atomica (Owned jointly by Agip Nuclear with 75% capital and Istituto per la Ricerche Industriale with 25% capital)	S.I.M.E.A.
7	Istituto per la Ricerche Industriale	I.R.I.
8	Societa Ricerche Impianti Nucleari (Consist of F.I.A.T. and Montecatini (Societa General per l'Industriale Mineraria E Chimica))	S.O.R.I.N.
9	Societa Elettronucleare Italiana (Associated with the Edison Volta Group)	S.E.L.N.I.
10	Istituto Nazionale di Fisica Nucleare (Subsidiary of C.N.R.N.) (Research divided between the Universities of Turin, Milan, Padua and Rome)	I.N.F.N.
11	Consiglio Nazionale Energia Nucleari. (Took over in 1958 from C.N.R.N. the regulation of research, the exploitation of nuclear resources, and the utilization of nuclear fuel and radioactive by-products)	C.N.E.N.
12	Cento Autonomo Militaire Energia Nucleare	C.A.M.E.N.
13	Istituto Mobilaire Italiana	I.M.I.

Table XXIII.—NUCLEAR POWER STATIONS UNDER CONSTRUCTION AND PLANNED IN ITALY

	Owner	Designer and manufacturer	Location	Type	Net electrical output of station	Fuel	Moderator	Coolant	Start of work on site	Date of operation	Remarks
					MW						
1	SIMEA	Nuclear Power Plant Co (NPPC) and AGIP-NUCLEARE*	Foce Verde near Latina	Natural uranium graphite moderated and CO_2 cooled (Calder Hall) type)	200	natural uranium	graphite	CO_2	21.11.58	1962	Contract signed Aug. 1958. Total cost £26 million. First nuclear power station in Italy.
2	SENN	International General Electric (U.S.A.)	Garigliano Valley (between Rome and Naples)	Double cycle boiling water (BWR)	150	enriched uranium	light water	light water	—	1963	Total cost $66 million. Site not finally decided.
3	SELNI	Westinghouse Electric International Corporation (U.S.A.)	Enrico Fermi project (North Italy)‡	Pressurized light water moderated and cooled (PWR)	160	enriched uranium	light water	light water	—	1963	Contract placed Dec. 1956. Scheduled to go critical early in 1963. Similar to Yankee Atomic Electric Co.†
4	SENN	International General Electric (U.S.A.)	Punta Fiume (North Italy)	Double cycle boiling water (BWR)	150	enriched uranium	light	light	1.8.59	1963	Contract placed in Feb. 1959.
5	SORIN	—	—	—	150	natural uranium	—	—	—	—	—
6	SORIN	—	—	—	150	enriched uranium	—	—	—	—	—

* AGIP-Nucleare will place local contracts, undertake civil engineering and building work and be responsible for testing of all components made in Italy.
† A significant proportion of the components of the equipment is to be made in Italy.
‡ Italia Compania Enrico Fermi Atomic Power.

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Table XXV.—SUMMARY OF TYPES OF RESEARCH REACTORS INSTALLED OR UNDER CONSTRUCTION IN EURATOM COUNTRIES (1956-1959)

1	2	3	4	5	6	7	8	9	10	11
Item	Type	Fuel	Moderator	Coolant	Belgium	France	Netherlands	Germany	Italy	Number
(a)	Solution (20% uranyl sulphate in water	uranyl sulphate	light water	light water	—	—	—	Frankfurt & West Berlin 50 kW	Milan 50	3
(b)	Natural uranium graphite moderated, air cooled	natural uranium	graphite	air	Mol BR-1 3000/4000 kW	—	—	—	—	1
(c)	Natural uranium graphite moderated light water cooled	natural uranium	graphite	light water	—	—	—	Munich (Garching)	—	1
(d)	Natural uranium light water moderated and cooled	natural uranium	light water	light water	—	—	—	—	—	0
(e)	Natural uranium heavy water moderated, gas cooled (COf)	natural uranium	heavy water	carbon-dioxide	—	Saclay EL-2 2000/2200 kW	—	—	—	1
(f)	Natural uranium heavy water moderated and cooled	natural uranium	heavy water	heavy water	—	—	—	Karlsruhe 10,000/12,000 kW	—	1
(g)	Enriched uranium light water moderated and cooled	enriched uranium	light water	light water	Mol BR-2 25,000/50,000	—	Delft A-57 10kW Petten HFR 20,000 kW Petten 20,000 kW	Munich Garching 1000kW Hamburg 5000 kW Julich (Merlin) 5000 kW	Saluggia (Milan) 1000kw	8
(h)	Enriched uranium heavy water moderated and cooled	enriched uranium	heavy water	heavy water	—	Saclay EL-3 15,000 kW Grenoble Melusine 1200 kW	—	Julich (Dido) 10,000 kW	Ispra (Milan 5000 kW	
(i)	Enriched uranium graphite moderated gas cooled (High temperature pebble bed design)	enriched	graphite	mixture of 22% helium and 78 % neon	—	—	—	Stetternich Julich 100.000 kW	—	1
(j)	Number of reactors	—	—	—	2	3	3	9	3	20

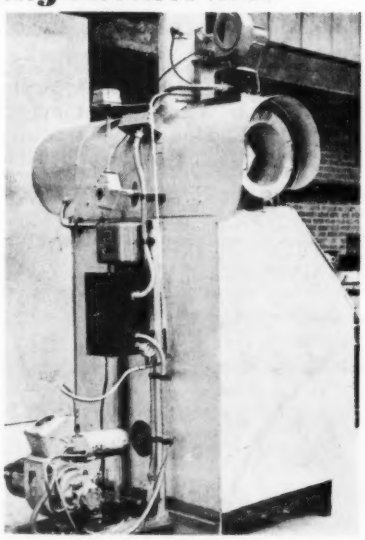
Smokeless Space-heating Incinerator

An incinerator which will get rid of any kind of rubbish (including rubber scrap) without smoke and at the same time provide a useful source of heat has been introduced by Boston Marine & General Engineering Company Limited, Deans Road, Wolverhampton.

The Hoskinson incinerator is an American invention, for which the Boston Company have the manufacturing rights for Europe and other territories. The British design team were able to incorporate so many outstanding additional features and improvements in efficiency that the Hoskinson is to be exported to the U.S.A. at the rate of 600 to 1000 per annum.

Smoke is a gaseous fuel and to burn it requires air for combustion and temperature for ignition. The fundamental principle of the smoke eliminating equipment is to supply both of these deficiencies to the smoke passing from the furnace.

At the base of the chimney is mounted a small oil burner, consuming approximately half a gallon per hour, and a forced draught fan. The air from the fan passes

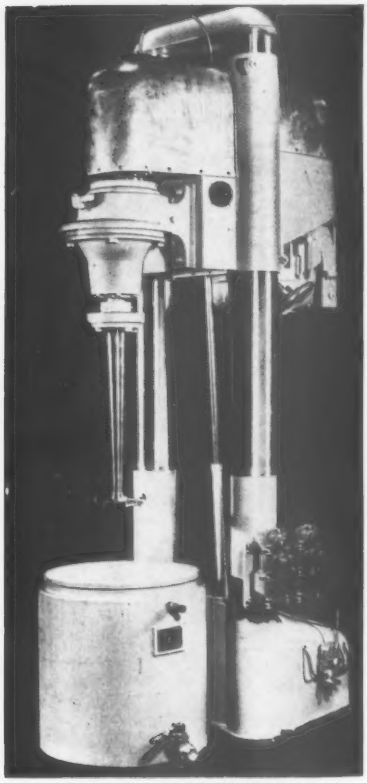


Automatic oil burner, wiring and smoke eliminator

through a diffuser and supports the combustion of the ignition oil flame and air to mix with the smoke, which burns continuously within the inner stack.

The chimney is designed as a carburettor and consists essentially of two concentric cylinders. Air passes into the annular space and becoming heated passes upwards, where it enters the chimney. This highly preheated air then mixes with the remainder of the smoke and complete combustion of the gases is assured.

RAMMER FOOT.—The ramming foot of the Pegson power rammer which has a striking force of 8000 lb, is now being moulded in a Rockite dough moulding compound by Cascelloid (Divs. of British Xylonite Company Limited). The compound, manufactured by British Resin Products Limited, Devonshire House, Piccadilly, London W1) possesses outstanding strength combined with excellent dimensional stability. It has very good abrasion resistance, is resistant to bacteriological attack and remains unaffected by extreme changes of temperature. Hence, it is ideally suited for this application. To comply with the weight specification Cascelloid have moulded cavities inside the foot. It is the largest DMC moulding in the country weighing some 13¾ lb. Maintenance is negligible as there is no question of rotting or corrosion.



Steel-Shaw Super Rapid disperser

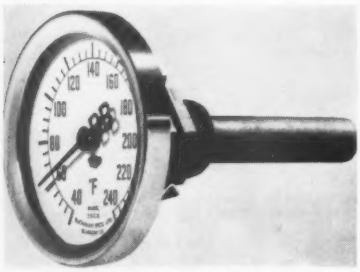
High-speed Dispersion

The new Super Rapid disperser introduced by Steele & Cowlishaw Limited, Hanley, Stoke-on-Trent, has been designed to meet the demand for machines to give improved products in considerably less time than by the conventional methods. The new disperser has many applications in the field of dispersion and solution of solids in liquids, especially where finely divided solids are required to be rapidly dispersed in viscous solutions of resins varnishes, lacquers and numerous other coating materials. It combines the advantages of high power with a high-speed impeller. The impeller can be easily cleaned when changing from one colour to another. The machine is designed for use with movable containers with capacities of from 25 to 150 gal. Another feature is the variable speed control which enables correct speeds to be selected to suit individual dispersions.

Laboratory and test facilities are offered by the company at their Hanley, Stoke-on-Trent, works.

Dial Thermometer

Latest in the range of Clyde industrial thermometers manufactured by Buchanan Bros. Limited, Glasgow, is the model "2·5 C.B." with through-back stem. A 2½-in. dial thermometer operated through a bi-metal element, it is available with the new Clyde Easiread scales graduated from 40/240° F and 0/300° F, also with



The new Clyde 20 in. dial thermometer

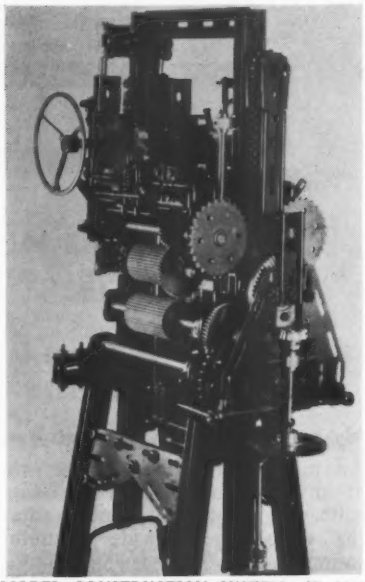
equivalent C. The movement is calibrated to give accurate readings throughout the range. The thermometer pocket extends 2½ in. below the hexagonal nut and the pocket is detachable by a spring clip. Fitting is ½ in. B.S.P. The case is robust and well-finished and as no glass is used the unit is capable of withstanding minor shocks in service. Prices range from 17/6 each.

Heavy Duty Grease Pump

The "Hercules" high-pressure pump introduced by Centralube Limited, Edmonton, London N18, is specially suitable for feeding heavy lubricants:

Centralube's new high-pressure pump can also be used used with positive dividers and can be adapted to operate with single and dual line lubrication systems

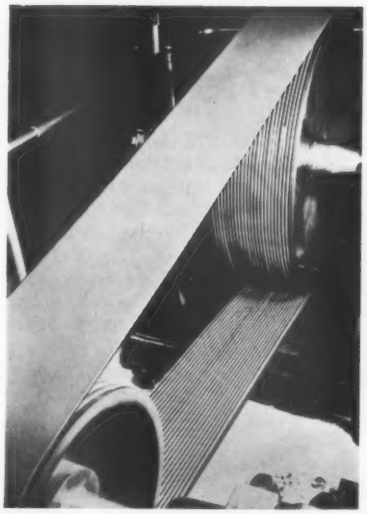
it is capable of pumping bitumistic materials, e.g., Shell Cardium C or D Compound, or Mobil Dorcia 150, and can operate at a maximum working pressure of 15,000 psi. The pump is foot-operated and every 20 to 40 applications a handwheel is turned down to ensure that the lubricant finds its way into the pressure chamber. The output per stroke varies slightly with the type of grease; in the case of a grease of penetration 250, it is 2·3 grams per stroke. The weight of the pump is just under 50 lb and it is equipped with two wheels for easy movement.



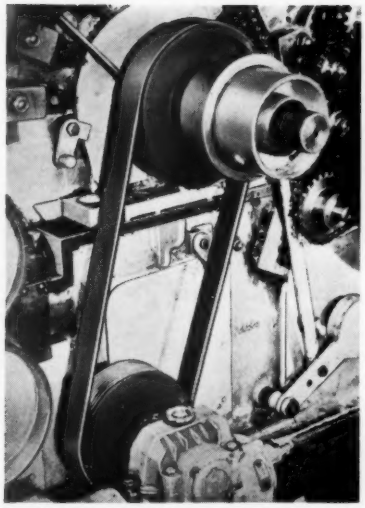
MODEL CONSTRUCTION SYSTEM.—Working models like this log saw reproduce the actions of the machines they represent and can be used as prototypes or for other experimental purposes. The model was built from elements of the Weyco Fac system ("Mechanical World", March 1960, p. 95), which uses round rods and beams, assembled into a framework and clamped together. There are no limitations on the size of supporting structures and small components may be mounted anywhere. An important feature of the system is a wide assortment of current machine units

Adjustable Oil Feed Indicator

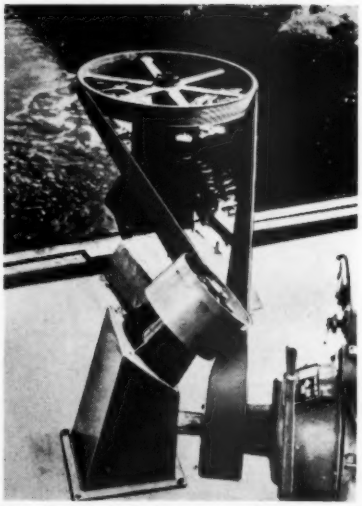
A small and compact oil feed indicator, 4 in. high × 1½ in. dia, which can be fitted into confined spaces and is yet capable of giving a very clear indication of the oil flow, has been designed and is being manufactured by Suba Hydraulics Limited, 86 Lind Road, Sutton, Surrey. The feed can be readily adjusted by means of a fine thread control from 3 gpm to complete cut-off while the system is still running. Pressures up to 125 psi can be handled. The flow adjustment cannot be accidentally altered or tampered with: an Allen key being necessary to carry out any alterations.



A single 9 in. wide M-section Poly-V belt replaced 10 D-section V-belts on this diesel alternator drive, saving 40% in pulley width.



Smooth running Poly-V drive replaced chain on this textile carding machine, thus eliminating frequent breakages previously arising from shock loads



The elimination of drag and chafing by narrow individual V-belts at sharp lateral bend enabled Poly-V drive to reduce the diesel fuel consumption on this pump drive from 2½ to 1¾ gph

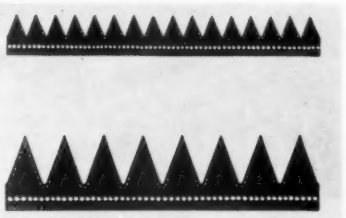
New Belt Transmits More Power

The "POLY-V" drive introduced by Turner Brothers Asbestos Company Limited, Rochdale, incorporates the best features of V-belt and flat belt drives and makes possible an increase in drive capacity of up to 50%. It combines the flexibility and simplicity of the flat belt drive with the higher speed ratios, shorter centre distances and freedom from slip of the V-belt drive.

The belt (Patent 720,344, others pending) is in effect a flat belt with a series of parallel V-shaped ribs moulded on its inner surface. These ribs form the driving surface of the belt and completely fill mating grooves on the pulleys, there being no clearance between the two, thus the load-carrying member extends across the full face of the drive (unlike the multiple V-belt drive where part of the total drive width available is wasted by the space between belts) and the grooved inner face of the belt has about twice the surface area in contact with the pulleys when compared with a multiple belt drive of similar width.

An interest to the industrial user is the versatility and simplicity of installation of the new drive. The POLY-V drive is made in three different profiles. Two of these, the L and M, between them cover the whole range of power transmission now covered by five different V-belt cross sections (none of which is interchangeable). This is because the load carrying member of the drive is carried above and outside of the pulley grooves and is thus quite independent of the size and shape of groove. The frequent difficulties met with in matching up V-belts are avoided completely and considerable savings in belt stocks and in time are possible.

For light drives where single V-belts are normally used there is a smaller POLY-V section available, the J section, which has great flexibility and offers freedom from vibration.

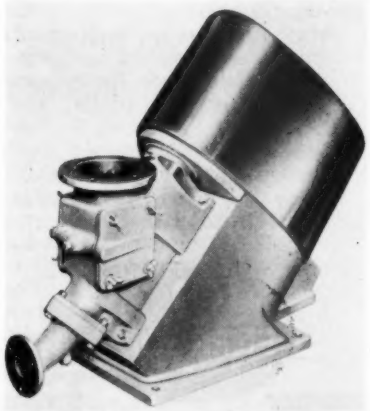


The Poly-V belt cross-section L has $\frac{3}{16}$ in. ribs and the M $\frac{3}{8}$ in. ribs. Appropriate widths cover the entire field of heavy duty power transmission belt requirements. The two Poly-V sections cover five standard V-belt sections

Designed to provide a low cost, space saving drive to operate silently and dependably over small pulleys of $\frac{3}{4}$ in. dia and upwards, the J section has small groove widths of $\frac{3}{32}$ in.

Pumps for Powder

The new Mono Junior powder pump, made by Mono Pumps Limited, 1 Sekforde Street, London EC1, is a small compact unit for the batch transfer of powder which can be applied for dosing or blending powders or for bleeding-off small quantities of powder from draw-off points in a powder handling system. The rate of discharge can be varied up to a maximum of approximately 5 cu ft. per hr. Both the larger P12 Mono powder pump and the Junior pump can be used on ring main piping systems, and a combination of the two pumps can assist in dealing with both continuous and intermittent discharge from draw-off points.



The Mono Junior powder pump, for discharge rates up to 5 cu ft of powder per hr, is a useful unit for small batch powder transfer and dosing

Nuclear Power Plants. Geneva; United Nations. London; H. M. Stationery Office. £6 5s. 0d. net (by post £6 7s. 3d.). 538 pp. 8½×11 in.

This volume and Vol. 8 already published together make up Parts 1 & 2 of the proceedings on nuclear power plants of the International Conference on the Peaceful Uses of Atomic Energy. Six types of reactor are dealt with, and in each case several different installations are described, some of them completed and some in the project stage. Covered in this way are reactors using water, boiling water, organic cooler, gas cooler, liquid metal cooler, and the homogeneous type using liquid metal, molten fluoride, etc.

Power reactor experiments are described on plants employing water, boiling water, gas, liquid metal, and also the homogeneous type, and experience is given from the operation of boiling water, organic, gas cooled and liquid metal cooled types. The text is very fully illustrated with graphs, charts, drawings and photographs.

The two volumes provide a most valuable compendium of knowledge and data on this rapidly growing subject. Together they complete the record as regards nuclear power plants. There are 33 volumes in the full series, covering every aspect of atomic energy for peaceful purposes.

Plastic Properties of Rolled Sections. By M. R. Horne. Abington, Cambridge, 1959; British Welding Research Association. 8/6 post free. 55 pp. 5½×8½ in.

Dr. Horne has compiled this book in the course of work being carried out at the Engineering Department of the University of Cambridge. He deals comprehensively with the plastic moduli, with and without load of British Standard rolled steel joists, British broad flange beams, universal beam sections, British Standard channels and special channels. A further section is devoted to the properties of British Standard equal and unequal angles. The book contains fully explained tables, in part extracted from B.S. 4:1932. Algebraic expressions for the various properties quoted, with details of their derivation, are given in three appendices. Advice on the content and form of the work was given by the D.1 (Load Carrying Capacity of Frame Structures) committee of B.W.R.A., and new information, provided by The Bethlehem Steel Co., U.S.A., The South Durham Steel and Iron Company and Dorman Long and Co., is included.

A Simple Approach to Electronic Computers. By E. H. W. Hersee. Glasgow, 1959; Blackie & Son Limited. 12/6 net (by post 13/-). 104 pp. 4¾ × 7¼ in.

To use an electronic computer one does not have to know anything of its electronics. The essential thing is to understand its mathematics, and for most purposes that is relatively easy. This book is not all that would be required by the user of a computer but it does give a clear and easy approach to understanding what the computer does, how (mathematically) it does it, and how it is used. The representation of numbers in digital computers is explained and enough is said of basic circuits to show what happens to the numbers in the machine. The memory or store is similarly treated as are the subjects of control, input and output. The digital computer at work is described and an equally useful introduction is given to special purpose digital computers and to analogue computers and their basic circuits. Finally and by way of example a description is given of the solution of a simple problem by an analogue computer.

books

Reading German for Scientists. By Hans Eichner and Hans Hein. London, 1959; Chapman & Hall Limited. 30/- net (by post 30/11). 207 pp. 5½ × 8½ in.

Anyone who really wants to read German scientific literature will make rapid progress with the aid of this book. To start with it teaches the *reading* of German without the complication of speaking or writing the language; and it teaches *scientific* German almost from the first page. In a very few pages the reader finds himself immersed in whole passages from typical scientific texts. The teaching of grammar is selective for the purpose so there is no tedious hold-up on this score, and the vocabulary right from the start is just what the scientist seeks to learn. The book is in three parts, the first teaches the reading of German, and the second and third provide passages for reading in chemistry and physics respectively. Included in an appendix are the Gothic alphabet and English-German and German-English vocabularies.

Theory of Mechanical Vibration. By Kin N. Tong. New York, 1960; John Wiley & Sons Inc. London; Chapman & Hall Limited. 78/- net (by post 79/3). 348 pp. 6×9 in.

This theoretical treatment is not restricted to topics having immediate applications. It treats first of systems having a single degree of freedom, presenting all the basic concepts pertaining to mechanical vibrations and goes on to the concept of vibration modes in a multidegree-freedom system, using a system with two degrees of freedom as a simple model. The results obtained are then extended by means of matrix algebra and generalized co-ordinates after which the vibration of continuous media is discussed, using relatively simple systems as illustrations. A useful outline of matrix algebra is given in an appendix.

Hydraulic Handbook.—The second edition of the "Hydraulic Handbook" follows very closely the pattern of the first in style and presentation of material and data, but considerable new information and technical matter has been added. The first and largest occupies over half the 800 and more pages, setting out and explaining the basic principles of hydraulics. It goes on to survey the various items of equipment and components, from accumulators to valves, which go to make up an hydraulic system; and then enumerates the applications of hydraulics to industries and end-products in agriculture, aircraft, automobiles, locomotives, machine tools, presses, general engineering, mechanical handling, mining, etc., etc. Technical data in the form of circuits, charts and tables occupy nearly 250 pages of Section 2. This section includes no less than 91 hydraulic and electro-hydraulic circuits, 126 tables with working examples, 23 nomograms, 23 charts, formulæ, British Standard Specifications and American J.I.C.

symbols, and an hydraulics dictionary. The third and final section comprises a buyers' guide consisting of a trade names index, a classified list of suppliers of hydraulic equipment and components and an alphabetical index of manufacturers with their addresses. Published by Trade and Technical Press Limited, Morden, Surrey, price £5-10-0 (post free).

Corrosion of heat-resisting alloys.—The first part of the findings of the Council of British Manufacturers of Petroleum Equipment's Corrosion–I Committee has been published in a report entitled "Corrosion of Heat-Resisting Alloys in the Presence of Fuel-oil Ash". A series of alloys was exposed to ash deposition in the superheater zone of oil fired boilers and the nature and extent of the corrosion related to nickel content and the relative proportions in the deposits of sodium and vanadium. The observations made indicate that in land-based installations there is preferential deposition of the vanadium present in the oil, whereas in a ship's boiler the proportion of sodium to vanadium in the deposits was increased, presumably by intake of sodium with the combustion air. The only alloy which was resistant to all deposits was ferritic 26% chromium steel which is deficient in strength at elevated temperatures. Of the other materials tested, austenitic steels of low nickel content were more resistant to deposits of low V:Na ratio and high nickel alloys were more resistant to deposits in which the V:Na ratio was high. The report is available, price 5/-, from the Council's offices at 2 Princes Row, Buckingham Palace Road, London SW1.

British Manufacturing in Mexico and Colombia.—An on-the-spot examination of opportunities for investment by British firms in Mexico and Colombia carried out by Dr. F. Chalmers Wright, M.B.E., consulting economist, has been published by the Federation of British Industries, 21 Tothill Street, London SW1, price 42/-.

British investment in Mexico has not kept pace with Mexican economic growth while other foreign investment in Mexico has increased substantially during the past decade. There are few legal restrictions on foreign investment in manufacturing in Mexico and the substantial producer there, whether foreign or Mexican, may be granted tariff protection. On Colombia the report makes clear the country's promising economic future: the opportunities for British manufacture there exist mainly in the field of producer goods especially metal and chemical products. Current development in Colombia's own steel industries will merit study by manufacturers looking for investment outlets in that market.

Process Integration and Instrumentation.—This is the title of the latest addition to the Electrical Development Association's series of "Electricity and Productivity" books. A study of the book indicates that the steps which lead from detection and measurement to indication, recording and eventually to automatic control are intricate and impinge on a wide range of specialized skills. Chemistry, physics, electrical, mechanical, electronic and nuclear engineering are involved, it is shown, all of which have their peculiar and rapidly extending vocabularies. The book outlines in simple form the means by which the variables occurring in manufacturing can be sensed, measured and controlled with the ultimate object of achieving a more completely and perfectly integrated process. Copies can be obtained from EDA Headquarters, 2, Savoy Hill, London WC2, at 8/6 or 9/- post free.

Better Chromium Plating. The deterioration of plating, particularly on motor cars, has caused a certain amount of criticism in recent years. To some extent, the tendency for plating on zinc alloy die castings to break down can be blamed on the use of too thin a deposit of nickel under the chromium. Another approach is to improve the coating of chromium and research has now shown how to produce coatings two or three times thicker without cracks developing. A booklet, "Better Plating on Die Castings", published by The British Non-Ferrous Metals Research Association, shows that the extra corrosion resistance of the plating is quite remarkable even though the chromium coating is still well below 1/10,000 in. thick. "Better Plating on Die Castings" discusses the modifications to plating techniques required for applying the improved coating and the control tests needed to ensure that the best results are obtained. It is available from The British Non-Ferrous Metals Research Association, Euston Street, London, NW1, price 7/6d.

Installing Marine Diesels.—A 51-page booklet has been issued by F. Perkins Limited, Peterborough, giving general notes on the selection and installation of Perkins marine diesel engines. It discusses propellers and stern gear, engine beds, water connexions and exhausts, fuel systems, electrical equipment, starting aids, engine controls, instrument panels, sound proofing, air cleaning, bilge pumping, V-drives, cooling systems, and gives scale outline drawings and performance charts of the various engines in the Perkins marine range.

Fuel Abstracts.—The Institute of Fuel has announced the issue of a new publication "Fuel abstracts and Current Titles". It will be a monthly classified summary of world literature on all the scientific and technical aspects of fuel and usage, and it will be supported by comprehensive annual author and subject indexes. It is obtainable from The Institute of Fuel, 18 Devonshire Street, Portland Place, W1, or through any bookseller, annual subscription 12 guineas.

New Standard

Bourdon tube pressure and vacuum gauges (B.S.1780:1960). Price 15/-.

This new standard specifies requirements for indicating pressure gauges, vacuum gauges and combined pressure and vacuum gauges of the bourdon tube type. The range of nominal sizes is 2–12 in. and the maximum scale readings are up to 16,000 psi or up to 6 ton sq in. Requirements are specified for test gauges with concentric scales and for industrial gauges with concentric and eccentric scales. The standard gives a range of sizes for direct mounting and surface mounting gauges and a series of standard pressure ranges and scale graduations. The seven sections deal with materials and construction, dimensions, accuracy, testing and inspection, marking and packaging. Buyers and suppliers will find particularly useful the list of 18 items of information which should be embodied in an order. The new standard concludes with nine appendices. Typical titles are "Notes on testing apparatus and methods" and "Recommendations on the installation and use of gauges."

British Standards Institution, 2 Park Street, London W1.

BUSINESS & PROFESSIONAL

Personal

Mr. F. Eric L. Bache has resigned as chairman of Geo. Salter & Co. Limited, the West Bromwich spring and spring balance manufacturers who this year celebrate their bi-centenary. He is succeeded by his nephew, **Mr. R. Philip S. Bache,** who has been managing director of the company since 1947, and will continue in this office additionally.

THE Engineering Group of The General Electric Company Limited of England announces the appointment of **Mr. E. W. Molesworth** as chief engineer for the London, Southern and Eastern Areas in succession to **Mr. C. J. O. Garrard,** who was recently appointed assistant general manager of the company's Erith engineering works.

Mr. C. H. Offord, general manager of the Newhouse (Lanarkshire) factory of Honeywell Controls Limited, has been made a director of the company.

Mr. A. M. Dallas, a senior representative of the Surform division of Firth Cleveland Tools Limited, a member of the Firth Cleveland Group, is to have his territory extended to include County Durham and Middlesbrough.

Mr. M. H. Beattie, E.R.D., M.I.E.E., formerly London sales manager of Scottish Cables Limited, has been appointed assistant sales manager (power cables) by British Insulated Callender's Cables Limited.

Mr. C. G. Hickling, A.M.I.E.E., has been appointed manager of BICC Middlesbrough Branch in succession to **Mr. G. W. Wheaton** who has taken up an appointment at their Prescot Works.

Mr. J. A. Rodgers, formerly assistant sales manager (mining), has been appointed to the position of divisional sales manager (accessories).

THE CRODA ORGANISATION LIMITED announce that **Mr. F. A. S. Wood** has been elected chairman to succeed the late Sir Edward Crowe, K.C.M.G. Mr. Wood retains his post of managing director of the company. **Mr. Norman Townend, F.C.A.,** has also been appointed a director.

THE TEMPERED SPRING COMPANY LIMITED, Sheffield, announce the appointment of **Mr. Eric Larner,** previously with Linread Limited, screw manufacturers of Birmingham, as manager of a new division recently created for handling the Rollpin, a spring type cylindrical fastener which replaces screws, rivets, etc.

Mr. R. D. Pearce, B.Sc.(Hons), has been appointed a director of Keeton, Sons & Co. Limited, of Greenland Road, Sheffield 9, manufacturers of fabricated steel machinery for the sheet metalworking industry, and a member of the Firth Cleveland Group.

Mr. John H. Whitaker, A.M.C.T., A.M.I.Mech.E., has been appointed sales manager of Hagan Controls Limited.

GEORGE KENT LIMITED announce the appointment to the board of directors of **Mr. John F. Willsher,** general works manager.

Dr. Cecil Dannatt, O.B.E., M.C., M.I.E.E., has been appointed vice-chairman of Associated Electrical Industries Limited, with the special responsibility of co-ordinating both commercial and technical policy. **Mr. H. West** has succeeded Dr. Dannatt at Manchester.

WICKMAN announce the appointment of **Mr. C. F. Watts** as a director of the company. Mr. Watts, who is a Fellow of the Institute of Chartered Accountants, joined the company in 1945 and was appointed secretary and later financial controller.

THE FAIREY COMPANY LIMITED announces that **Mr. R. L. Lickley, B.Sc., D.I.C., M.I.Mech.E., F.R.Ae.S.,** has resigned from the board and has relinquished his appointments with the subsidiary companies of the Fairey Group.

BRITISH RAILWAYS (SCOTTISH REGION) announce that **Mr. A. D. R. Watson, B.Sc.(Eng.), A.M.I.C.E., A.C.G.I.,** has been appointed district engineer, Inverness.

Mr. W. Newland Williams, who has been with Stream-Line Filters Limited since the formation of the company, has now been appointed sales manager for Dunedin Engineering Company Limited, 73/75 Mortimer Street, London W1.

BAILEY METERS & CONTROLS LIMITED of Purley Way, Croydon, are pleased to announce the appointment of **Mr. V. A. Plumley** as manager of the Bailey meter division of Steam and Mining Equipment (Pty.) Limited, as from March 1, 1960.

GRIFFIN & GEORGE LIMITED announce that **Dr. A. J. P. Martin, C.B.E.,** has retired as a director of the company to concentrate primarily on fundamental research work. He is succeeded, as director of research, by **Mr. R. C. Palmer, M.A.(Cantab.),** his present deputy.

Mr. Arnold W. Lee, managing director of Norton Grinding Wheel Company Limited, has been appointed to the board of directors of Behr-Manning Limited, Belfast, an associated company manufacturing coated abrasive products.

Dr. R. L. P. Berry, beryllium project manager since 1958, has been appointed to the board of ICI Metals Division.

Dr. Edmund T. Price, B.S., L.H.D., of San Diego, California, has been appointed managing director of Tiltman Langley Limited.

Mr. N. R. D. Gurney, A.C.G.I., M.I.E.E., has relinquished the position of manager, AEI Heavy Plant Division's Large Electrical Machine Sales (Manchester), but will remain a member of the executive of heavy plant division. **Mr. I. A. Ferguson, M.I.E.E.,** hitherto manager, Large Electrical Machine Sales (Rugby) assumes responsibility for the entire department and **Mr. J. Cannell, B.Eng., A.M.I.E.E.,** is appointed assistant manager.

Obituary

WE regret to record the death of **Mr. W. J. Belsey,** who, until his retirement, was for forty-two years with the British Thomson-Houston Company, now AEI (Rugby) Limited. He retired from the managership of the marine department in 1944 but remained with the company for a time in a consultative capacity.

WE regret to record the death of **Mr. Richard Patrick Creagh,** a director of Simms Motor & Electronics Corporation Limited.

Addresses

FIRTH CLEVELAND FINANCE LIMITED has opened a new branch office at Liverpool with Mr. D. W. Ritchie as manager. The address is State Insurance Buildings, 14, Dale Street, Liverpool 2. Telephone, Maritime 1228-9.

WELWYN ELECTRICAL LABORATORIES Limited, of Bedlington, Northumberland, have now changed their name to Welwyn Electric Limited.

CIMEX-FRASER TUSON LIMITED has changed its name to Cimex Limited.

THE Incandescent Group announces that the London office telephone number is now Belgravia 7803-5.

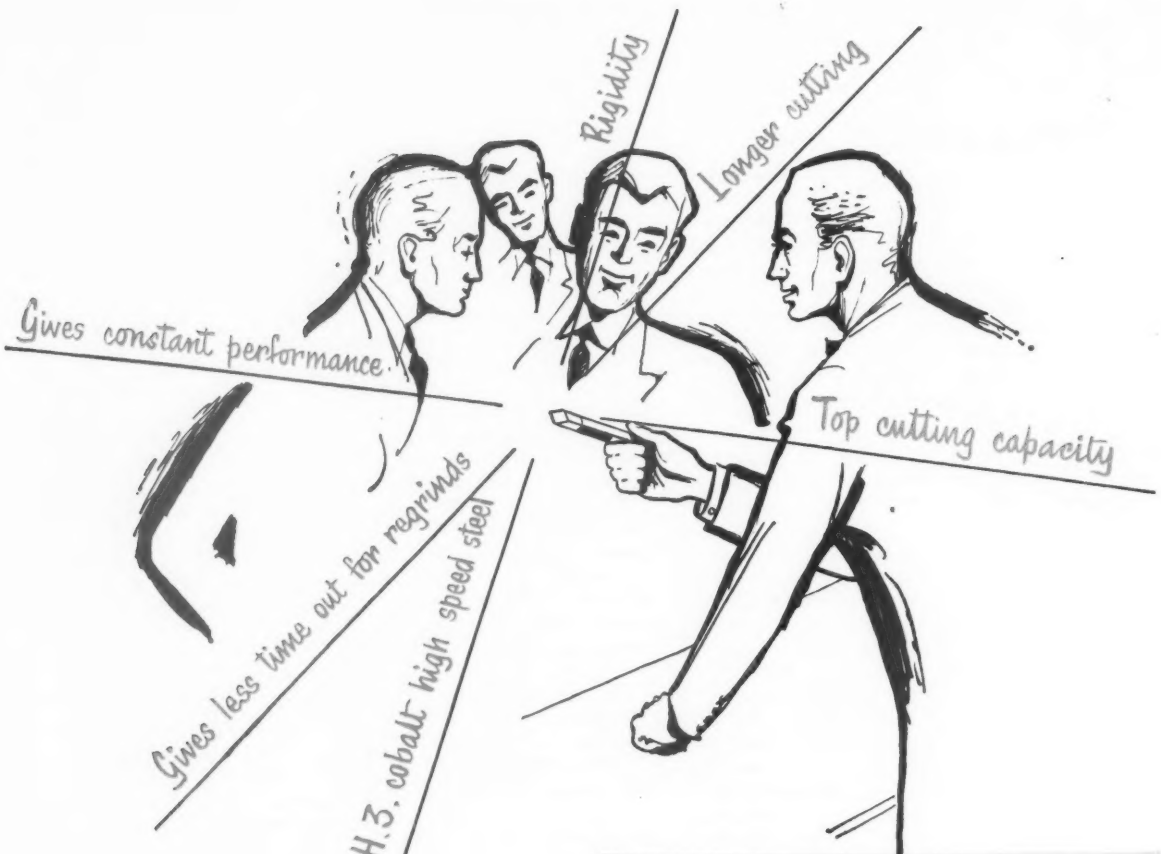
A NEW company centred at Crawley, Telcon Metals Limited, has been formed by British Insulated Callender's Cables Limited, to assume responsibility for all the activities of the Metals Division of The Telegraph Construction and Maintenance Company Limited.

THE Dumfries branch of the British Insulated Callender's Cables Limited has an additional telephone number, Dumfries 2402.

A NEW company, D. S. Hilton & Co., of 2 The Crossways, New Ferry, Ches., has been formed to pack and distribute activated alumina in standard packs of 1, 2, 4 and 8 oz.

THE new address and telephone number of Precision Components (Barnet) Limited is

that extra little bit . . .



It is the consistent high quality and the exceptional ability of "Eclipse" tool bits to retain a keen cutting edge that puts that elusive production target within your reach.

A tool bit is only as good as the steel it's made from, and "Eclipse" tool bits are made from the finest H3 Cobalt High Speed Steel. In other words, you can rely upon fast, accurate cutting and know also that time-out for regrinds is reduced to an absolute minimum.

Use "Eclipse" tool bits in "Eclipse" tool bit holders from today; together they provide the finest cutting combination.

Eclipse

TOOL BITS

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UTI5

Kabi Works, Cranborne Road, Potters Bar, Middlesex. Telephone Potters Bar 3444.

W. B. CULL & SONS LIMITED have now moved to their new factory at Powke Lane, Old Hill, Staffordshire.

THE Alloys Division, Union Carbide Limited, Glasgow Office address is now at Cornhill House, 144 West George Street, Glasgow C2. The telephone number remains unchanged, Central 6454.

RANSOME & MARLES BEARING COMPANY Limited have removed their Leicester area office from Great Central Street to De Montfort House, 223 Belgrave Gate, Leicester. The telephone numbers are unchanged.

THE new Sheffield depot address of Scaffolding (Great Britain) Limited is at Petre Street, Sheffield 4 (telephone Sheffield 388212), and is under the managership of Mr. Walter Hopewell.

Contracts and Work in Progress

WESTINGHOUSE BRAKE AND SIGNAL COMPANY Limited.—Installation of vehicle battery chargers for the Port of London Authority.

WILLIAM BAIN & Co., Coatbridge and London.—Contract valued at over £30,000 for the supply of steelwork for bridges for the new Ayr to Prestwick By-pass.

CLARKE, CHAPMAN & Co. LIMITED. —Order from Central Electricity Generating Board for steam generating plant. Estimated cost £6m.

BOWMAKER (PLANT) LIMITED, Willenhall.—Order for £1¼m. worth of Caterpillar tractors for Institute Nacional De Reforms Agraria of Havana.

ASSOCIATED ELECTRICAL INDUSTRIES.—*Turbine Generator Division*: Order from the Municipality of Singapore for 25-MW turbine-generator set for Pasir Panjang power station, value over £400,000. *Electronic Apparatus Division:* Analogue computer for Ford Motor Company Limited, Engineering Research, Birmingham. *Traction Division:* Supply of electric traction equipment worth about £2¾m. to South Africa. *Heavy Plant Division:* Orders value nearly £500,000 placed by British Oxygen Engineering Limited for centrifugal air compressors and driving motors. Mine winders with a total value of £475,000 for collieries in South Wales, Scotland and Yorkshire.

TAYLOR WOODROW CONSTRUCTION LIMITED —Contract worth about £350,000 awarded by the Solartron Electronic Group Limited, for office and factory buildings at Farnborough, Hants.

W. H. ALLEN SONS & Co. LIMITED.—Large contract for dual-fuel engines and diesel generating sets for crude oil pipe-line project in Northern India.

This is the Salter cake which was presented to the chairman of Geo. Salter & Company Limited of West Bromwich on the occasion of their bi-centenary year party given to the Press. The cake which weighed 40 lb was made by Taylor, Law & Company Limited. ("Tala" kitchenware) and all the decorations are edible

FERRANTI LIMITED, Hollinwood.—Order worth over £300,000 for high-voltage testing equipment for U.S.S.R. through v/o Machino-import of Moscow.

BRITISH OXYGEN LINDE LIMITED.—Two large tonnage oxygen plants at Modderfontein in South Africa for African Explosives and Chemical Industries Limited.

Two plants for Scottish Gas Board, Westfield, Fifeshire.

First tonnage oxygen plant for new steelworks at Rourkela and Durgapur.

BRITISH RAILWAYS.—Contracts have been placed by the Scottish Region with Don (Contractors) Limited, Inverurie (provision of diesel maintenance facilities), and with James Campbell & Son, Inverness (provision of workshops and offices, demolition work, etc.).

Business Developments

Trading Agreements

FERRANTI LIMITED and the Bendix Aviation Corporation have reached agreement for the sale in the U.S.A. of the new Ferranti systems of machine tool control developed at Edinburgh.

AGREEMENT has been reached between Pantak Limited of Vale Road, Windsor, Berks, and Sierex Limited of 241 Tottenham Court Road, London W1, for the marketing and servicing of the Siemens 15 meV industrial betatron.

FOUNDRY AND METALLURGICAL EQUIPMENT Company Limited, have made arrangements with Benno Schilde A.G. of Bad Hersfeld, Germany, to manufacture and market in Gt. Britain and Ireland, drying equipment operating on the Benno Schilde System. The company is also making and marketing in this country, the 'Lo-Smoke' die sprays and die machine lubricants developed in the U.S.A. by Aldridge Oils Inc.

BRAY CONSTRUCTION EQUIPMENT LIMITED, Feltham, have entered into an arrangement with Klockner & Co., Duisburg, Germany, for the marketing of the Bray range of tractor shovels.

Agents and Distributors

GREENGATE AND IRWELL RUBBER COMPANY Limited of Manchester, manufacturers of conveyor belting, and Conflow Limited of Nottingham, manufacturers of spray equipment, valves, gauges and other accessories, have appointed the American subsidiary of Megator Pumps and Compressors Limited as their sole agents in the U.S.A.

W. J. MEDDINGS LIMITED and Inca Engineering Company announce arrangements whereby the resources of both companies will be handled on a sole selling basis by W. J. Meddings Limited.

AGREEMENT between Baker Perkins Limited of Peterborough, and the German firms of Leonh Herbert and Paul Troester, will allow the British firm to manufacture and sell rubber processing and moulding machinery previously made in Germany.

AEROSTYLE LIMITED, London NW10, are sole distributors in the United Kingdom and the Commonwealth for the Statron portable equipment for electrostatic painting.

Company Acquisitions

THE Simms Motor & Electronics Corporation Limited has acquired for cash the whole of the issued capital in Cawkell Research & Electronics Limited of Scotts Road, Southall, Middlesex.

THE north country civil engineering and railway contracting firm of Grant, Lyon & Co. Limited has been acquired by the Chamberlain Group of companies.

MAJOR interests in Auto-Stackers Limited have been purchased by John Brown & Co. Limited and Standard Telephones and Cables Limited.

Film News

A Day at the Renault Works.—Some idea of the production techniques employed to achieve the high degree of efficiency where, "every 18 seconds, a Renault car engine from one factory meets a body from another on the other side of Paris," is given in this 25 min. colour film, produced in France by the Renault Film Service, and now available on free loan from the G.B. Film Library, Perivale, Middlesex.

The Things People Want.—This film deals with the technique of selling and will be of special value to retail selling organisations. Produced by the Jam Handy Organisation of Michigan, in black and white, it is available from the G.B. Film Library, Perivale. It is of 20 min. duration and can be hired at a cost of £3 or purchased for £40. Cat. No: IF.7307.

More than Words.—Produced by Henry Strauss and Co. Inc. of New York, and now available from the G.B. Film Library, Perivale, Middlesex, this film instances a number of difficult situations which would have been avoided if clear communication techniques had been employed. The need for a better understanding of the governing

factors which should form the basis for every instruction is stressed, and the clever use of animated cartoon helps further to emphasize the points made. In colour, 13 min. duration, hire charge £2 or purchasing price £32 10s. Cat. No: IFC.7303.

Fescol's "25-year Club"

FESCOL LIMITED, electro-chemical despositors and engineers (North Road, London N7), recently held a luncheon in London for its "25-Year Club" at which seven new members were introduced, bringing the total membership up to 35. This club was started some years ago by the directors of the firm, for employees with more than 25 years' service. The seven new members were each congratulated by the managing director, M. F. B. Strachan, and presented with a clock in recognition of their long service. Among the new members were Mr. C. W. Hay, works manager at the Port Glasgow factory, and Mr. W. Chapman, manager of the machine shop in the London works.

The Halcrow Bequest

THE Institution of Civil Engineers announces the establishment of the "Halcrow Bequest," provided for in the will of the late Sir William Halcrow, President in 1946-47, who died in October, 1958. It will take the form of an annual premium of £50 for award to the author of the best paper published by the Institution on specified subjects. These are docks and harbours, tunnels, and hydro-electric power—among subjects in which the late president specialized. Only corporate members of the Institution are eligible for a premium. The subjects will be changed in a three year cycle. Papers delivered over the previous three years on any one subject will be considered.

Canadian Dam Consultants

THE engineering consultants for the new thermal power station near Estevan, Saskatchewan, Canada, were Ewbank and Partners (Canada) Limited, a Canadian subsidiary of the British Company of the same name. This is the first completed thermal power station in Canada in which the consultant services have been provided by the associates of a British firm of engineering consultants.

Chemical Engineers

THE regulations for admission to graduate and associate membership of the Institution of Chemical Engineers have been revised and these revisions are included in the booklet of Regulations just issued. Enquiries should be addressed to J. B. Brennan, general secretary of the Institution, at 16 Belgrave Square, London SW11.

Industrial Safety Trophy

THE Sir George Earle Trophy for industrial safety achievement has been awarded this year to Associated Electrical Industries (Manchester) Limited (formerly Metropolitan-Vickers Electric Company Limited).

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Silicone Fluids

Midland Silicones Limited have recently published a well-illustrated technical booklet describing the engineering applications of their range of Silicone fluids. Amongst established applications, silicone fluids are already well known in damping devices, liquid springs, fluid couplings, and hydraulic power transmission units. The booklet, 'Engineering Guide to MS Silicone Fluids', emphasizes that silicone fluids are outstanding for their exceptional thermal stability and resistance to oxidation. They are water-repellent and retain good dielectric characteristics over a wide range of temperatures and frequencies. Amongst the other desirable properties are low volatility, low freezing point, high flash point and incompatibility with organic oils and polymers. The booklet has many charts and tables. The booklet (Ref. No. G.11) is freely available from Midland Silicones Limited, 68 Knightsbridge, London SW1, or from Area Sales Offices in Birmingham, Glasgow, Leeds, London and Manchester.

Needle Bearings in Machine Tools

The advantages offered by needle roller bearings, more particularly for machine tools, are clearly set out in a new publication issued by INA Needle Bearings Limited, Dafen, Llanelly, Carmarthenshire. The needle rollers are available in circular cages (both axial and radial, the latter for taking thrust), in flat cages for rectilinear motion, and in various bearing forms including one with adjustable clearance, and in several combinations with ball races. A number of sectional drawings illustrate typical applications of needle roller bearings in machine tools.

Philplug Screwfix

Two new leaflets from Philplug Limited, Chase Road, London NW10, describe the use of Screwfix, a material for fixing screws into walls without the size or shape of the hole being important. The material is a mixture of asbestos and cementatious powders and requires only moistening to be ready for application. It will carry full weight immediately. It can also be used for filling cracks and crevices.

Factory Sites at Cumbernaud

Cumbernaud is a new town situated between Glasgow and Edinburgh, with good rail and road connexions and within easy reach of sea and airports. A standard type of factory has been designed to meet the requirements of the majority of light industries in the 10,000–80,000 sq ft class. Full particulars of the new town and its factory designs are set out in a new brochure available from Cumbernaud Development Corporation, Cumbernaud House, Cumbernaud, By Glasgow.

Diesel Shunting Locomotives

An illustrated brochure from John Fowler & Co. (Leeds) Limited, Hunslet, Leeds 10, sets out the advantages of the diesel-engined locomotive and describes the different types of transmissions used with it. Fowlers, who have been continuously engaged in the building of locomotives since 1865, offer a complete range with a choice of power unit, hydraulic or mechanical transmission, 0-4-0 or 0-6-0 wheel arrangements, multiple units and flameproofing, which provides for almost every industrial requirement. Data on the locomotives are set out clearly and concisely in chart form.

Terminal Blocks

The new price list of KABI terminal blocks contains particulars of new 120 150, 200 and 300 amp blocks, in single or multiple units, with or without cover. The 12-way terminal strips and certain blocks can now be had with N.P. phosphor bronze clamping strips. A new 2-way 5/15 amp block has a heat resistance of almost 500°C. The makers are Precision Components (Barnet) Limited, 13 Byng Road, Barnet, Herts.

Chains and Slats

The carrier chain and slats as used for conveying in the sugar industry is the subject of an illustrated catalogue from The Mirrlees Watson Company Limited, Glasgow. Detailed dimensions of the chain links and attachments are given and also weights and strength.

Separator Screen

Loss due to entrainment in evaporators is a cause of trouble in sugar factories. In the oil industry a similar problem has been overcome by the use of a special knitted wire screen which does not suffer from fouling. Details are given in a technical leaflet available from The Mirrlees Watson Company Limited, Glasgow.

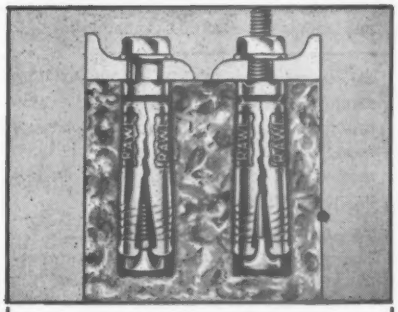
Timing Device

A time delaying apparatus which is essentially a solenoid operated mechanical escapement, operating a changeover switch at the end of adjustable time delay, is

SOLVE YOUR FIXING PROBLEM WITH ONE OF THE 21

However tough or awkward the material into which you want to fix, or difficult the problem, there will be among the 21 TYPES OF RAWLPLUG FIXING DEVICES, the right answer. Speed and simplicity of application, reliability and complete security, coupled with the RIGHT solution to a problem, are the foundations of the RAWLPLUG FIXING TECHNIQUES.

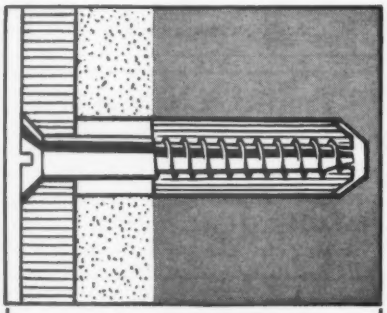
A comprehensive catalogue showing these fixings in detail, together with their application, will gladly be forwarded to you on request.



BOLT FIXINGS

With **RAWLBOLTS** a bolt fixing job is done in minutes, as against days by earlier methods. Simply drill the hole, drop in the **RAWLBOLT**, put into place the unit to be held, tighten up and the **RAWLBOLT** is ready to take the maximum load that the bolt, or the material into which it is fixed, will stand.

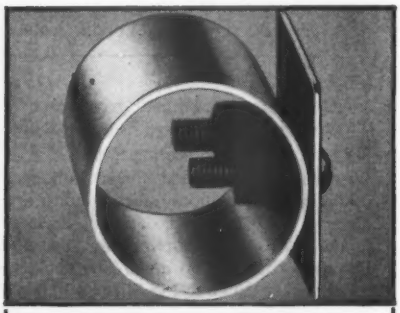
For extremely wet or corrosive locations, use Rawlplug Caulking **BOLT ANCHORS**; for securing metal threads in masonry—**RAWLTAMPS**. Where fixing points can be predetermined before pouring concrete, use **CEMENT-IN SOCKETS**, thus obviating the need for hole-boring.



SCREW FIXINGS

For making neat, absolutely firm screw fixings in masonry, indoors or out, the famous **RAWLPLUG** is still vastly quicker and more efficient than any alternative method. Rawlplugs are waterproof and quite unaffected by climatic conditions. They are available for all screw sizes up to ¾" diameter Coach Screws.

For fixings that are to be subjected to high temperatures, or in under-water conditions, use **WHITE BRONZE PLUGS** with stainless steel or cadmium plated steel screws. For fixings subject to corrosive fumes or liquids, use Rawlplug **LEAD SCREW ANCHORS** with stainless steel screws.



CAVITY FIXINGS

The **RAWLNUT**—an ingenious device for fixing into any hollow materials. Inserted and fixed from the outside, it forms its own anchorage within the cavity; and provides a vibration-proof, watertight and **AIRTIGHT** fixing. In addition a type can be supplied to give adequate protection to the screw **IN THE CAVITY**.

SPRING TOGGLES make firm fixings in thin and structurally weak materials such as plasterboard, ceilings, etc. The wings of the device spring apart behind the material and spread the load. **GRAVITY TOGGLES**, for use in hollow wall materials, position their toggles by the action of gravity.

THERE ARE 21 DIFFERENT TYPES OF

RAWLPLUG WALL PLUGS

FIXING DEVICES

and an all-inclusive range of high performance hole-boring tools, hand or power.

B567

THE RAWLPLUG COMPANY LIMITED • CROMWELL ROAD • LONDON, S.W.7

described in a leaflet from Electrical Remote Control Company Limited, The Fairway, Bush Fair, Harlow, Essex. It has alternative switching actions and the time range may be from 1–10 sec to 1–5 min. The switching capacity is 5 amp.

Centrifugals

A new brochure has been issued by Pott, Cassels & Williamson Limited, Java Street, Motherwell, Lanarkshire, describing their latest types of electrically driven centrifugals designed primarily for the sugar industry. The modern requirement is to suit automated sugar manufacture and after exhaustive tests the company have developed a machine which is fully automatic, well constructed and of streamlined appearance.

New Factories

Anfield Plain. Ransome and Marles Bearing Co. Ltd., Newark. Factory extensions covering 100,000 sq ft. The architects are J. H. Napper and Partners, 133 Osborne Road, Newcastle upon Tyne.

Birtley (Co. Durham). The Artic Fuse and Electrical Manufacturing Company Limited are to erect an office block in Windsor Road. The architects are Pennell and Baddiley, Bridge End Chambers, Chester-le-Street, Co. Durham.

Boldon (Co. Durham). Sykes and Son, Fuller Road, Sunderland, are to carry out alterations to provide mineral water factory. The architects are G. T. Brown and Son, 14 Grange Terrace, Sunderland.

Carlisle. Acco Limited, engineers, etc., are to extend their premises on the Durranhill industrial estate.

Chester-le-Street. The Gosforth Motor Company Limited are to erect motor workshops and showrooms to plans by J. W. Hilton, Brunton Park, Gosforth. The work will be carried out by the Coseley Civil Engineering Company Limited, Wolverhampton.

Eston (Yorks). The South Durham Steel and Iron Company Limited are to construct a new beam mill at their Cargo Fleet Works. The scheme is being considered by the planning authorities.

Felling (Co. Durham). The Hackbridge Cable Company Limited, Hackbridge, Brentford, Surrey, propose offices, warehouse, and storage facilities at Hepburn Gardens.

Gateshead. J. W. Capstaff Limited, haulage contractors, Benton, Newcastle upon Tyne, are to erect 25,000 sq ft transport depot on Team Valley Estate. The architect is M. L. Kubik, 14 Meridian Way, Newcastle upon Tyne 7.

The Bren Manufacturing Company Limited are to extend their factory by 35,000 sq ft to plans by G. H. Gray and Partners, Portland Terrace, Newcastle upon Tyne.

Hartlepool. Steetley Magnesite Company Limited. Large-scale extensions are proposed at the Hartlepool works.

South Shields. Tyne Chemical Company Limited. Plans have been approved for factory extensions at River Drive. The contractors are the Alston Limestone Company Limited, Lynwood Terrace, Westgate Road, Newcastle upon Tyne.

Stockton-on-Tees. Aycliffe Properties Limited, Churchill House, Newton Aycliffe. The architects for proposed offices, showrooms, workshops, and filling station at Skinner Street, are Scott and Clark, Regent Chambers, Wednesbury, Staffordshire.

Sunderland. William Doxford and Sons (Engineers) Limited are to adapt North Quay as a fitting-out base for new ships to relieve pressure on their Palmers Hill Engine Works.

J. A. Jobling and Company Limited, glassware makers, Wear Glass Works, are planning extensions on 14 acres of land which will provide work for another 1000 people. The name of the architects for the work is not yet available.

Alexander Rose Limited, clothing manufacturers, Leeds, propose three storey workshop on the site of the Boilermakers' Hall, West Sunniside.

Steel and Company Limited. The architects for proposed additions to offices at Crown Works are S. W. Milburn and Partners, 9 Esplanade.

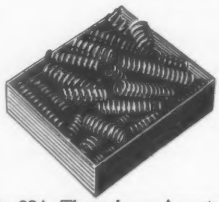
Continued over

THAT *Experimental Spring* YOU WANT IS WAITING FOR YOU IN THIS BOX ...

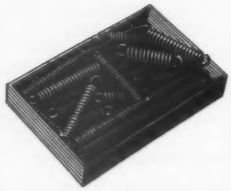
No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

If not, try another box in the Terry Assorted Springs range

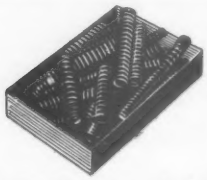
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



No. 98A. Three dozen Assorted 1″ to 4″ long, $\frac{1}{4}$″ to $\frac{3}{4}$″ diam., 19G to 15G. **5/6.**



No. 753. Three dozen Assorted Light Expansion $\frac{1}{4}$″ to $\frac{1}{2}$″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **10/6.**



No. 760. Three dozen Assorted Light Compression Springs. 1″ to 4″ long, 22 to 18 S.W.G., $\frac{1}{4}$″ to $\frac{1}{2}$″ diam. **6/6.**

No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{2}$″ to $\frac{7}{16}$″ diam., $\frac{1}{2}$″ to 2$\frac{1}{2}$″ long, 27 to 19 S.W.G. **15/-.**

No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{4}$″ to $\frac{1}{2}$″ diam., $\frac{1}{2}$″ to 2″ long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
We can only show a *few* boxes. Send us a p.c. for our full list.
If ever you are stuck with a spring problem let our Research Department put their long experience at your disposal.

Have you a Presswork problem?

If so, the help of our Design Staff is yours for the asking.

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Really interested in Springs? "Spring Design and Calculations" 9th Edition tells all—post free 12/6.

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from $\frac{1}{4}$″ to $\frac{3}{8}$″.

Looking for good Hose Clips? Send for a sample of Terry's Security Worm Drive Hose Clip and price list.

HERBERT TERRY & SONS LTD

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(*Makers of Quality Springs, Wireforms and Presswork for over 100 years*)

HT30

Continued from previous page

Short Brothers Limited. The contractors for the proposed re-alignment of the shipyard building berths are Brims and Company Limited, Pandon Buildings, City Road, Newcastle upon Tyne.

Thornaby (Yorks). Head, Wrightson and Company Limited, Teesdale Ironworks, are to erect an office block.

Aberdeen. John Henderson & Co. Limited, King Street, have received permission to make extensions to their foundry.

Acton. G. R. M. Heat Treatments Limited, Coronation Road. Extensions are to be made to the factory.

Auland Limited are to extend their factory in Sunbeam Road.

Basingstoke. Lansing Bagnall Limited. A new works is to be built at Kingsclere Road.

Batley. Birstall Carpet Company Limited, Huddersfield Road. Factory extensions.

Belfast. Richardsons Chemical Manure Company Limited and Ulster Manure Company Limited, 19 Short Street. New factory at Herdman Channel.

Bolton. Rutland Mills Limited, Adelaide Street. Extensions to works.

Bradford. H. & A. C. Nutter Limited, Dowley Gap Saw Mills, Bingley. Extensions to works.

Bristol. Parton Industrial Plating Company Limited. The architect for extensions to works is Raymond Moxley, Chesterfield Chambers, Westbourne Place, Clifton.

Hygienic Drinking Straws Limited, College Road, Fishponds, are to make extensions to their works.

Cambuslang. Hoover (Electric Motors) Limited, Somerville Street, are to extend their factory.

Cannock. Grainger & Smith Limited, 19 New Mill Street, Dudley. A new factory is to be erected on the Wolverhampton Road site.

Carlisle. E. Clews Limited, Torrington Avenue. Factory extensions.

Chesterfield. Robinson & Sons Limited. The Portland Works are to be extended.

Croydon. The Patent Steam Carpet Beating Company Limited, Zion Place, Zion Road, Thornton Heath, are to extend their works.

Dagenham. Jones & Stephany Limited, Shacklewell Lane, London E8. Extensions are to be made to the factory at Fowler Road.

Doncaster. Pilkington Bros. Limited, have a long term plan for extending their works at Kirk Sandall.

Ealing. P. Ormiston & Sons Limited, 31a Denmark Road, London W13, have made application for permission to extend their works.

Peboc Limited, Belvue Road, Northolt. Factory is to be extended.

Enfield. United Flexible Metallic Tubing Company Limited. A new factory is to be built at South Street.

Hemel Hempstead. S. Russell & Sons Limited, 25 Victoria Street, London SW1. New factory.

Ipswich. Allied Bakeries Limited, 40 Berkeley Square, London W1. A new bakery is to be built at Whitton White House industrial estate.

Kidderminster. C. Walters & Co. Limited. New factory.

Kingston-on-Thames. Chrystal Products Company Limited, Hook Rise, Surbiton. The architects for the new factory are W. S. Hattrell & Partners, Hanover House, Hanover Square, London W1.

Liverpool. Standard Triumph International Limited are to erect a large new factory on the Speke Industrial Estate.

London. J. H. Smith & Sons (Leyton) Limited, 46 Beaumont Road, London, E10. A new factory is to be erected at Church Road, Leyton.

Luton. W. Grigg Limited, North Street, are to build a new factory in Dudley Street.

Macclesfield. Geigy Pharmaceutical Company Limited are to erect a new factory on a site on Hendsfield industrial estate.

Oxford. W. Lucy & Co. Limited are planning alterations and additions to their Eagle Ironworks.

Port Sunlight. Lever Bros. Limited. Large extensions and modernization plans are to be undertaken.

Portsmouth. Highbury Tankers Limited. The architect for the new factory to be built in Fitzherbert Road is L. Chandley, The Shrubbery, Grove Road South, Southsea.

Redditch. Reynolds T. I. Aluminium Limited, Studley Road, have applied for permission to erect a tube mill.

Frederick Field & Sons (Redditch) Limited, Windsor Road. New factory.

New Factories

Romford. British Steam Specialties Limited, 16 Clerkenwell Road, London EC1. New factory.

Sedgley. Wrekin Electro-Plating Company Limited, Holloway Street, are to replace their factory.

Slough. Modern Wheel Drive Limited, Perth Avenue. Plans have been approved for the erection of a new factory at Bath Road.

Smethwick. Adams & Marshall Limited. A light engineering workshop is to be built at Grove Lane.

Southall. Foreson Partners Limited, North Hyde Lane. Factory extensions.

Stretford. Locomotors Limited, Elevator Road, Trafford Park. Extensions to works.

Sutton Coldfield. Metallurgical Refineries Limited. Extensions are to be made to the works in Forge Lane.

Tunbridge Wells. Harris Engineering Company Limited, North Farm industrial estate. Plans have been approved for extensions to factory.

Weymouth. C. & J. Clark Limited, of Street, Som., are to erect a new factory at Chickerell industrial estate.

Wolverhampton. Chubb & Sons Lock & Safe Company Limited, Cleveland Road. Factory extensions planned.

Aberdeen. William Wilson & Co., plumbers merchants and metal workers, are to take over the Mannofield Bus Depot from the Corporation at a cost of £32,000.

Edward Waldie (Aberdeen) Limited, of 66 Union Row, have added new departments to fabricate heating equipment, plumbing and electrical equipment and installation.

Canvas Products Limited of Tipton, are to erect a new factory at Bridge of Don to manufacture tarpaulins and canvas products.

Ayr. The Scottish Stamping and Engineering Company Limited of Neptune Works, are to build a new forge bay at a cost of £10,400 and further extensions for inspection at a cost £1000.

Bonnybridge. Rollo Industries Limited have developed diatomite working at Bernera in the Hebrides, shipping to Bonnybridge to process and mill for car polish production.

Broxburn. G. W. Laing of High Street, Corstorphine, Edinburgh, are to open a new factory at Broxburn for the manufacture of spring units and general engineering goods.

Dunbar. Associated Portland Cement Manufacturers Limited have indicated intention to seek planning permission for a £4 million opencast limestone project at Dunbar Cement works, estimated to produce 400,000 tons of cement per year.

Dundee. National Cash Register Company Limited are to get an additional £300,000 factory block at Dundee Industrial Estate. Work will begin in May and take 15 months to complete.

Falkirk. The Falkirk Brass and Sanitary Engineering Company Limited have now transferred to Mungalend Works, Bankside, Falkirk.

Glasgow. Northern Trailer Company Limited, Colston Ironworks, Auchinairn Road, Glasgow, is to extend space for the manufacture of semi articulated trailers. Tractor units for the trailers may be provided from the new B.M.C. plant at Bathgate.

Union Tank Car Company of Chicago have acquired an interest in Mechans of Scotstoun, general engineers. They will manufacture a range of Union Tank products for the chemical, industrial waste, sewage and gas storage industries.

Robinson, Dunn & Company Limited, sawmillers and timber merchants, are to erect an extension to their sawmill at 45 Byron Street, Glasgow W1.

Percy & Halden Limited are to erect an extension to their lubricating oil and edible fat factory at Milnpark Street and Stanley Street, Glasgow.

Port Glasgow. Three new factories have been approved for erection at the Port Glasgow Industrial Estate. Work will start on these immediately and Dean of Guild approval has been given. They are for Wovenair Limited, making house coats and rainwear, at a cost of £10,630; Playtex Limited, making foundation garments will add a third factory of 85,000 sq ft at a cost of £215,500, employing 500; and Aircraft-Marine Products Limited will take over a new 56,860 sq ft on completion, cost £152,085.

Hawick. Wilson & Glenny Limited, tweed manufacturers. The new £500,000 mill will be equipped in April and production should begin in June.

Irvine. British Federal Welding and Machine Company Limited of Dudley are to take space in the Irvine Industrial Estate.

Daniel Dunlop, sheet metal workers of Kilwinning Industrial Estate, are to transfer to the new Irvine Industrial Estate. They will handle general engineering products.

Irvine Industrial Development Committee report that a textile company is seeking a lease of ground at East Road, Irvine, and that two Swedish companies are interested in factories there, including an electro-plating company.

Paisley. Pressed Steel Company Limited will expand at Linwood to undertake car body manufacturing.

Scunthorpe, Lincs. and Stocksbridge, Sheffield. United Steel Companies Limited. Two United Steel companies, Appleby-Frodingham and Samuel Fox, plan to increase steel output. The former company is to install a new rod/bar mill.

Severnside, South Gloucestershire. Imperial Chemical Industries Limited. New ammonia plant to be built at a cost of upwards of £10m.

Heysham. Imperial Chemical Industries. Extension of methanol plant.

CLASSIFIED ADVERTISEMENTS

Situations Vacant

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New Zealand
SCHOOL OF ENGINEERING

Applications are invited for the following appointment:
SENIOR LECTURESHIP IN MECHANICAL ENGINEERING

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The salary scale for a Senior Lecturer is £1750 per annum rising to £2000 per annum by three annual increments, the first two of £100 and the third of £50. Commencing slary within this scale will be determined according to qualifications and experience An allowance is made towards travel and removal expenses.

Further particulars and information as to the method of application should be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London WC1.

Applications close, in New Zealand and London, on **30th June, 1960.**

"£1,000 a Year"

WE, a Midland Company of Engineers & Welders, will pay the above salary to Engineer Draughtsmen & Estimators required to fill vacancies which include interesting work on large Aluminium Tanks, argon-arc welded. Good canteen facilities, Pension Scheme and excellent prospects. Applicants must hold the H.N.C. or equivalent. Reply in confidence giving experience and qualifications to:— Box No. OW27.

Situations Wanted

YOUNG skilled *mechanic*, several years' experience as a fitter, acquainted with all works in this field, knowing electrical and autogenous welding, seeks employment in order to learn the language. Has a slight knowledge of English. Available June 15th, 1960. Good certificates and references. Offers to Box E 50683 G, Publicitas, St-Gall/ Switzerland.

Machinery, Plant and Accessories For Sale

10ft × ¾in. CRAIG & DONALD PRESS BRAKE for sale. Pressure 400 tons. All steel construction. Model 400/10 Motorised with 50 hp motor suitable for 400/3/50. F. J. Edwards Limited, 359 Euston Road, London NW1. Euston 4681 or 41, Water Street, Birmingham 3, Central 7606.

POWER Plant Company type DHR5 double helical reduction gears 35 hp 730/45 rpm 3 available, with or without totally enclosed fan cooled slipring motors and automatic starters, 400 volts, 3-phase, 50 cycles. Photograph and further details available on request. Dynamo & Motor Repairs, Ltd. North End Road, Wembley Park.

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C., 134 Great Portland Street, London W1. MUSeum 4480.

FANS! ! ! for Dust, fume extraction, air conditioning, compressors, accessories, motors, etc.; at considerably reduced prices. People say—"If only we'd known of you before . . . Write for very interesting list. Bellangers, 306 Holloway Road, London N7. North 4117.

PUMPS for all purposes. R. L. Christiansen Limited, Wordesley, Stourbridge. Brierley Hill 78184/5.

Patents For Sale or License

THE proprietor of British Patent No. 685422, entitled "Improvements in Variable Speed Wire Spray Gun", offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building, New York 17, New York, U.S.A.

Classified advertisements are inserted at the rate of 3/– per line.

THE proprietor of British Patent No. 630142, entitled "Method and Apparatus for Distilling Carbonaceous Material" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 S. Dearborn St., Chicago 3, Illinois, U.S.A.

THE proprietor of Patent No. 768595 for "Improvements in or relating to Variable Pitch Propeller", desires to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co. 28, Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of Patent No. 766508 for "Improvements in or relating to Hose Reel Units" desires to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co. 28, Southampton Buildings, Chancery Lane, London WC2.

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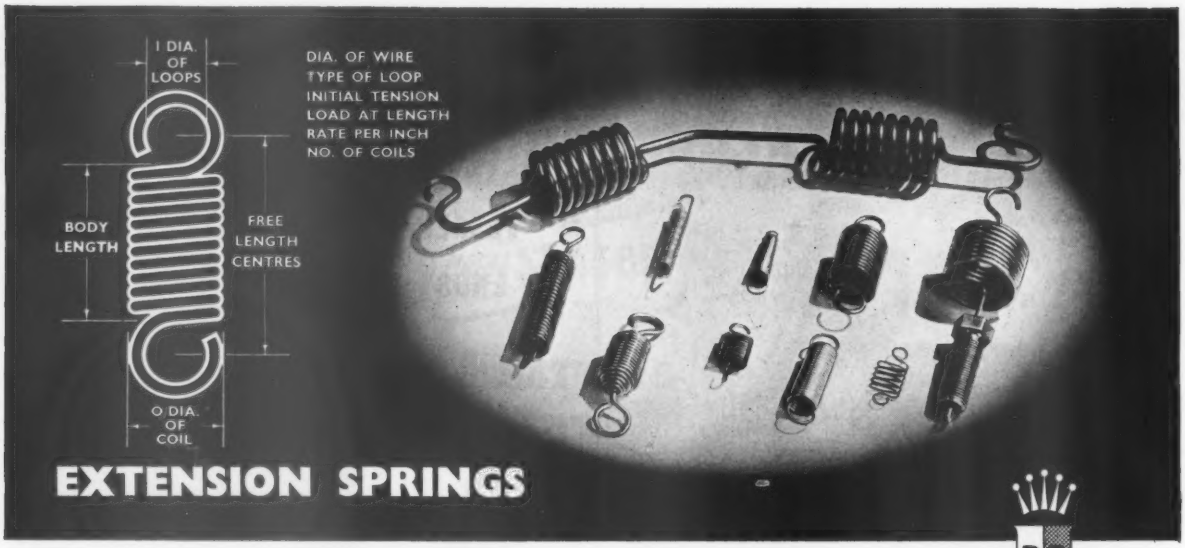

This photograph shows a few examples of high-quality precision springs, made by Riley. Some were produced to customers own specifications, others were the result of recommendations by the Riley design and research department. If you have any kind of spring problem, Riley will find the answer to it.
(The diagram shows information required when ordering this type of spring.)

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The "Highfield Fancool" Range consists of three sizes 4", 6" and 8" centres and is in addition to our other standard ranges. All are available for early delivery. May we send literature?

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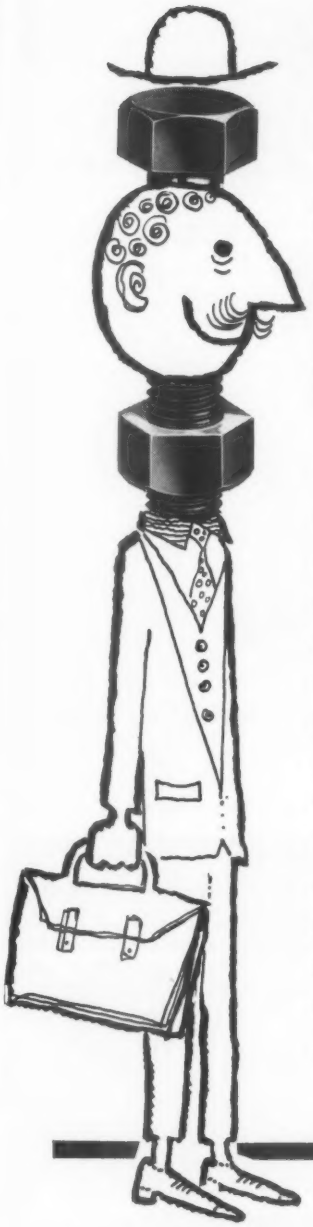

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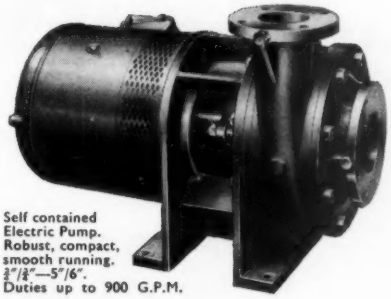

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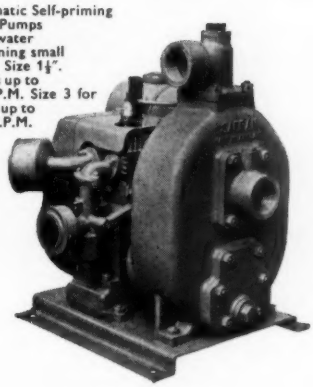

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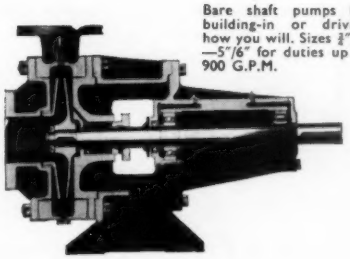

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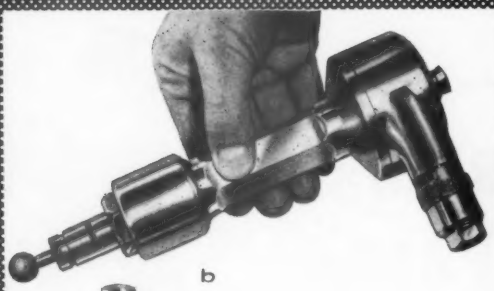

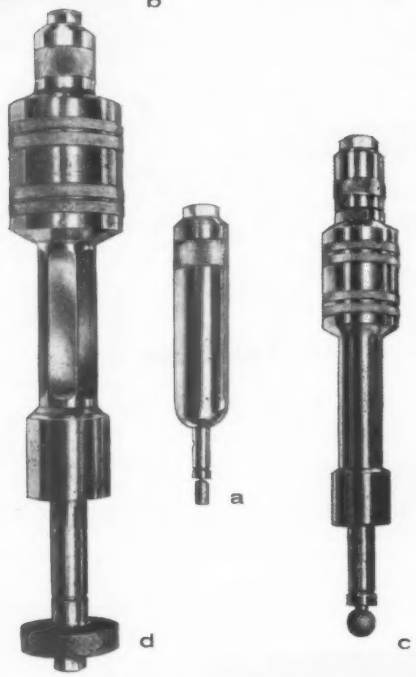

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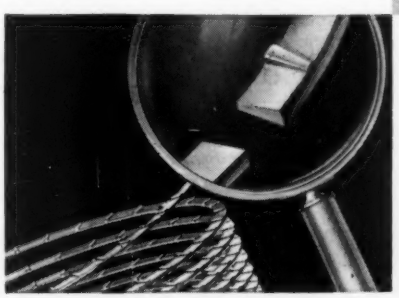

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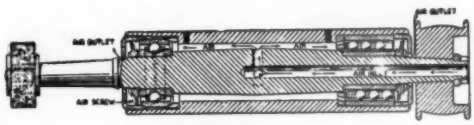

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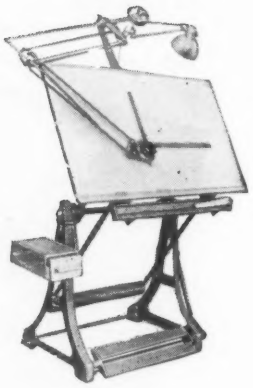

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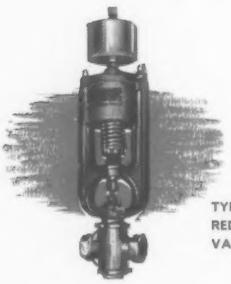

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